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A. B. CONNER, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

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DIVISION OF CHEMISTRY

The Composition and Utilization of Texas Feeding Stuffs

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

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This Bulletin contains a discussion of the constituents of feeding stuffs, their digestion, utilization, and composition. Variations in composition of the feeds are discussed. The averages of the composition of over 600 kinds or classes of feeding stuffs are given, based on over 22,000 analyses, in turn taken from over 55,000 analyses made in this laboratory. The average productive energy and digestible protein are also given for a large number of feeds. Suggested standards for feeding are given, together with methods for calculating the cost of protein, productive energy, and bulk, for calculating constituents of a ration and for reducing the cost of a ration.

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BULLETIN NO. 461 NOVEMBER, 1932

THE COMPOSITION AND UTILIZATION OF TEXAS FEEDING STUFFS

G. S. FRAPS

It is the purpose of this Bulletin to discuss the composition and utilization of Texas feeds, and to give the average composition of feeds used in Texas, based upon many analyses. Analyses of several thousand feeds of various kinds were made by this Division in the course of investigations of the composition and properties of feeds. Many of these have been published (5, 7, 9, 10, 11, 12, 13, 14, 16). Also analyses have been made for other Divisions of the Experiment Station, especially in connection with feeding experiments. Since the law controlling commercial feeding stuffs was passed in 1905, this Division of the Experiment Station has made analyses of over 53,000 samples of commercial feeds for the Division of Feed Control Service. It was of course not advisable to use all of the analyses referred to for the purposes of this Bulletin; manufacturing processes of commercial feeds have been improved or changed, making it necessary to disregard some older analyses, especially of commercial feeds. Many of the analyses were of feed mixtures, which are not discussed in this Bulletin. However, the number averaged is large, being about 22,355.

WHAT ANIMALS REQUIRE IN FEEDS

Feeding stuffs, when combined to furnish a ration that keeps animals healthy and productive, must furnish sufficient protein, sufficient material to produce energy, sufficient minerals such as lime, phosphoric acid, magnesia and iron, and sufficient vitamins such as vitamins A, B, C, D, E, and G. If the ration provides only enough material and energy to sustain the body, without gain or loss of weight, the animal is said to be on a maintenance ration. If the animal is expected to work or to produce milk or eggs, or to put on flesh and fat, a productive ration must be furnished. The excess of the ration over maintenance requirements may be used for productive purposes.

This Bulletin deals only with the ordinary chemical constituents of feeds, namely, the protein, fat or ether extract, nitrogen-free extract, crude fiber, water, and ash. The fat, nitrogen-free extract, and crude fiber, as well as the protein, furnish energy. The minerals and vitamins will not be discussed here but are left to subsequent Bulletins.

DEFINITIONS OF TERMS

Proteins are the constituents of the feed which, when digested and assimilated, can be used to form flesh, muscle, hair, ligments, blood, and other portions of the animal body. Protein furnishes material to replace wear and tear of the animal body, for additional flesh, and for other nitrogenous constituents. It is an important constituent of eggs and milk. Protein can also be burned in the body to produce heat or energy, or it may be used by the animal for the production of fat, but it is usually a more expensive source of heat or fat than some of the other constituents of feeds. When proteins are digested, they are split up into a number of chemical compounds, called amino acids, which are united again in the animal to produce animal protein or other needed substances. Some proteins are deficient in one or the other of the amino acids necessary for the building of the animal proteids, and require supplementing by other proteins which supply these necessary constituents. Other proteins furnish more of one particular amino acid than is needed, and in such case the excess can be used only for heat or energy. For this reason, pure proteins differ in their feeding value, but as most of the proteins in feeds are mixtures of several proteins, and as different kinds of feeds are usually fed in mixtures, these differences in proteins tend to be equalized in the daily ration of the animal. The matter is one which still needs extensive study.

Protein is usually the most expensive portion of a feed, so that feeds high in protein usually sell for a higher price than feed low in protein. However, there are times when cottonseed meal, which is high in protein, sells at such a low price that no money value can be assigned to the protein (17). When protein is high in price it is more economical to feed as little protein as is consistent with good results, but when protein feeds such as cottonseed meal are low in price, it is economical to feed as much protein as the animal can utilize without harmful results. Normally, protein costs more than energy, and the values of different lots of the same feeds high in protein are related to their protein content.

Fats, or ether extract, are that group of constituents of the feed soluble in ether. The ether extract is ordinarily referred to as fats and oils, and this is substantially correct for concentrated feeding stuffs, such as cottonseed meal, corn, rice bran, etc. Although some other substances are present, the ether extract in these feeds is composed mainly of fats and oils. The ether extracts of hays and fodders, however, contain large proportions of waxes, coloring matters, and other substances (23, 24), so that it is not strictly correct to apply the names fats and oils to the ether extract of these roughages. Fat, after it is digested, is used by the animal as a source of body fat and to furnish heat and energy. It is a more concentrated source of energy than the other constituents of feeds, one pound of fat being approximately equal to 2.25 pounds of starch, sugar, or other carbohydrate. Feeds of the same kind containing high percentages of fats are thus likely to have a higher productive value for feeding than those containing lower percentages of fat. An excess of fat is likely to impair digestion.

Crude fiber is that portion of a feed which resists the action of hot 1.25 per cent sulphuric acid and hot 1.25 per cent caustic soda solution, a purely arbitrary method of analysis. It consists chiefly of the cell walls and woody material of the plants. Crude fiber is digested and utilized to some extent by ruminants, such as cows, sheep and goats, and also by horses. Crude fiber is poorly digested by pigs, chickens, and humans, and has little value to them. Crude fiber usually consists chiefly of cellulose, which, although a carbohydrate, is difficult to digest and utilize.

Crude fiber not only has a low value in itself, but is usually accompanied by other materials which also have low feeding values. Crude fiber in cottonseed meal above about 4 per cent (9) comes from cottonseed hulls, which have a much lower feeding value than the kernel. Crude fiber, above a certain minimum, in rice bran or rice polish, comes from rice hulls (10). A high crude fiber content of a hay indicates the presence of a high percentage of woody material. A high crude fiber content of alfalfa hay indicates a high proportion of stems and a low percentage of leaves, and a low feeding value. A low content of crude fiber indicates a high content of leaves, with consequently higher feeding value. Other feeds could be cited in which a high content of crude fiber indicates a high content of less valuable material. Thus, as was said above, the crude fiber not only has a low feeding value in itself, but is an indicator of the quality of the feed.

Nitrogen-free extract is a group of substances consisting of starches, sugars, dextroses, pentosans, organic acids, phytin, lignin, and other substances. Sugars, starches, and pentosans are carbohydrates. The nitrogen-free extract of many concentrated feeding stuffs consists chiefly of carbohydrates, that is, of compounds which, in addition to carbon, contain hydrogen and oxygen in the proportions to form water. The nitrogen-free extract of hays, fodder, cottonseed hulls, oat hulls, and similar materials high in crude fiber, contains large percentages of lignin and other substances which are not carbohydrates. The nitrogen-free extract when digested and assimilated, can be used by the animal to produce fat or carbohydrates, or it can be used for the production of heat or other forms of energy. Animals need large quantities of materials which furnish energy, for the uses of the body or for productive purposes.

Ash is the residue left when the feed is burned. It represents chiefly the mineral part of the feed, though much of the sulphur and chlorin and part of the other constituents may have been volatilized and lost during the burning. The lime and phosphoric acid of the ash are used by the animal for production of bones and for other purposes. Salt is also required by animals. An excess of minerals, however, is of no advantage to the animal but it decreases the feeding value of the feed. An excessive amount of ash may indicate contamination with earth or sand or other useless material, but when the ash of tankage or other animal by-products is high, it is chiefly due to bone.

Water is unavoidably present in all feeds, as moisture. The higher the water content, the lower the percentage of materials of feeding value. Thus, a feed containing 12 per cent water would contain about 4 per cent less feeding value than a similar feed containing 8 per cent. Over 12 per cent water in corn chops or similar feeds may cause heating and spoiling (6), especially in warm weather, unless special precautions are taken. Excess of water in hay may cause spontaneous combustion, and burning of the hay, if precautions are not taken to avoid it. Feeds high in water may be preserved by special methods, such as those which are used for the production of silage. Texas feeds, as a rule, contain less water than those in some of the other sections of the country, probably on account of the somewhat drier climate.

Nutritive ratio: The nutritive ratio is the proportion of digestible protein to digestible non-protein, chiefly carbohydrates. In calculating the nutritive ratio of a feed or a ration, the percentage of digestible fat (ether extract) is multiplied by 2.25, the product is added to the percentage of digestible nitrogen-free extract and digestible crude fiber, and the sum is divided by the percentage of digestible protein. The quotient is the nutritive ratio. If the nutritive ratio of a feed is said to be 1:8, it means that the feed contains one part digestible protein to eight parts digestible non-proteid organic matter.

The fat is multiplied by 2.25, for the reason that it is a more concentrated form of nourishment than nitrogen-free extract or crude fiber, and has 2.25 times as much value to the animal.

If the ration contains sufficient protein and sufficient energy, the nutritive ratio is automatically correct and need not be considered separately.

COMPOSITION OF TEXAS FEEDING STUFFS

Table 11, near the end of this Bulletin, gives the average composition of about 625 Texas feeding stuffs, based upon our best present knowledge. The figures for the concentrated feeds are, to a large extent, based upon the analyses made for the Texas Feed Control Service for several years past. The figures for hays, roughages, and all other materials are based upon Texas analyses of the Agricultural Experiment Station. The number of analyses averaged is about 22,355.

DIGESTION OF FEEDS

Digestion converts food into forms which, dissolved or emulsified in water, pass through the walls of the digestive organs, and can be utilized by the animal body. Digestive organs of different animals have different sizes and capacities and are adapted to varied kinds of food. The digestive organs of cows, sheep, goats, and other ruminants are comparatively large and are suited for the utilization of large quantities of feeds containing comparatively small quantities of nourishment. The digestion organs of the dog, pig, chicken, and similar animals, are much smaller and are not suited to utilize bulky feeds, such as hays, fodders, or straws. The digestive organs of the horse, although of large capacity, do not have the capacity of that of the ruminants such as the cow; and, for this reason, the horse has a lower digestive power and is less well suited for the utilization of the coarser feeding stuffs.

The horse is also unable to chew his food over again. The difference between the digestive power of the horse and ruminant is more marked for crude fiber, for which the horse has only a low digestive power.

A number of losses occur in the process of digestion.

In the first place, that part of the food that is not digested passes through the body and is eliminated in the solid excreta.

In the second place, a portion of the food is converted into gases, such as marsh gas and carbon dioxide. Since the food converted into gases disappears during the process of digestion, it obviously has no value to the animal organism. Some energy is excreted in the liquid excrement.

In the third place, there is a loss due to the work required for the digestion. The chewing of the food, movements of the body, secretion of the digestive juices, and the various operations involved in digestion, use up a portion of the energy of the food.

After all these losses have been deducted, what remains is the net value of the food to the animals. As stated above, animals vary somewhat in their ability to digest food. There are also differences in individuals, due to the conditions of the teeth, the condition of the digestive organs, etc. The composition of the ration also has some effect on the digestion.

If the proportion of non-protein to protein is excessive, the digestibility of the ration is decreased. With pigs, the nutritive ratio may be 1:12 with no decrease in digestibility, but, with other animals, an increase in non-proteids which increases the nutritive ratio beyond 1:10, results in decreased digestibility of the ration. The addition of feed rich in digestible protein, increases the digestibility of such a ration, until the nutritive ratio becomes 1:10, or, in the case of pigs, 1:12, after which additional quantities of protein are of no advantage in increasing digestibility.

Digestible protein is the protein which disappears during the passage of the feed through the animal. The animal is fed a known quantity of feed, and the solid excrement from this quantity of feed is collected. Both feed and excrement are analyzed. The difference between the quantity of protein fed and the quantity of protein in the excrement is defined as the quantity digested. It is less than the protein actually absorbed by the animal, for the reason that some of the protein in the excrement is waste body material. However, the digestible protein is a good measure of the protein which an animal can take from a feed. Coefficients of digestibility for protein by sheep (18), chickens (19), and pigs (22), have been published by the Texas Agricultural Experiment Station.

Digestibility of other constituents. The digestibility of other constituents of feeds is measured in the same way as that of protein, and tables giving the average coefficients of digestibility are available. A summary of digestion coefficients for ruminants is given in Bulletin 329 (18), and a supplement in Bulletin 402 (20), while a summary for chickens is given in Bulletin 372 (19), and for pigs in Bulletin 454 (22). Variations occur in the coefficients of digestibility secured in various tests, so that there is some variation for the average digestibility shown in the tables, in individual cases. This is especially likely to be true when only a few experiments are averaged.

UTILIZATION OF FEEDS

As stated above, when food is digested, there are considerable losses, due to undigested food, to gases, and to the work involved in digestion or metabolic processes consequent on the digestion. After these losses are deducted, the remainder of the food represents the net value of the food to the animal. The net food value may be defined as the nourishment that is secured from the food after deducting all losses involved in the digestive processes of digestive metabolism, including the work of digestion.

This net nutriment must, first of all, be used for taking care of the bodily needs of the animal, and then the excess, if any, may be used for productive purposes.

As already stated, the animal must have a certain amount of food with which to build up the muscular tissues which are wasted away through the processes of life. The animal must also have food supplies to keep the body warm and to maintain heat. The quantity of heat required will depend to some extent upon the temperature of the surroundings. In cool surroundings some of the energy liberated in digestion, may be used to heat the animal body. The animal must also have food to take care of the various bodily movements of the lungs and the beating of the heart, movements of other body organs, and movements of the body which are essential to the life and well-being of the animal.

The needs of the animal may be grouped into two classes:

First, tissue-building materials or food needed for the building of tissue or for the repair of tissue consumed during the life processes of the animal.

Second, energy-forming materials, which may be used for heat or energy, or stored up as fat, or in the non-protein constituents of milk, eggs, or other animal products.

The protein of food is its only constituent which can be used either for the repair of the animal tissue or for the building of lean meat. It is, however, required only in comparatively small amounts by full-grown animals. Growing animals, that are building tissues rapidly, require relatively large quantities of protein. Animals giving milk or fowls laying eggs, also require large quantities of protein, on account of the protein contained in these products.

The other constituents of the food provide energy for heating the animal, for digestion, for bodily movements, or for the production of milk or fat. The nitrogen-free extract, the fat, and the crude fiber, may all be used for energy, fat, etc., in this way. If an excess of protein is fed beyond the needs of the body for the other purposes mentioned above, the protein may also be used for production of energy. Protein, including the tissues of the body, may also be used for energy when the ration fed does not supply a sufficient quantity of energy. The animal then loses flesh.

It is usually not economical to feed protein to be used for energy purposes, since protein is ordinarily somewhat more expensive than the other forms of feed. There are, however, conditions under which it is profitable to feed protein for energy purposes. This is particularly the case in some parts of the South, including Texas, where cottonseed meal may at times be cheap enough to be fed for its productive value or value for producing fat or energy, rather than for its content of protein. In fact, the price of cottonseed meal is at times so low that its protein value may be disregarded.

PRODUCTIVE ENERGY OF FEEDS

The value of a feed for building or repair of flesh, is measured to a certain extent by its content of digestible protein. However, the digestible protein of different feeds may have different biological values, and the biological value of the digestible protein of a ration depends upon the biological values of the constituents of the mixture and of their supplemental value.

The value of a feed for heat, bodily movements, or energy, or for productive purposes, is not so easily measured. The best measure that we have at present is the quantity of fat that it will produce upon a fattening animal. This, expressed in terms of energy, we call the productive energy of the food, or its fat-producing value, and it indicates not only the quantity of a fat that the food may be able to produce, but the relative value of the food for other purposes, such as for work, for energy, for uses of the animal body, etc.

The productive value of a food is experimentally ascertained by first feeding an animal a ration which should produce a little fat and estimating by respiration experiments exactly how much fat is produced with this ration. Then to this ration the food to be tested is added, and the quantity of fat produced is again estimated exactly. This cannot be done by weighing the animal, as such a method is too crude for exact work. The difference between the first quantity of fat produced and the second quantity of fat produced, shows how much fat the food is capable of producing, when it is fed to an animal that is already receiving enough food to take care of its bodily needs. It is then a simple matter to calculate the fat-producing value or productive energy of the feed tested. The productive energy of feeds has also been compared by means of feeding experiments (25). The productive value for work, for milk, or for other purposes, can also be measured. For practical purposes, it is convenient to use only one of these values.

The productive energy, stated in terms of therms, is the most advanced method of measuring the value of a feed stuff. In the calculation of rations for animals, it was formerly assumed that the digestible nutrients of one food are equally as good as the digestible nutrients of any other food. As a matter of fact, this is not true. Different feeds vary considerably in the value of the digested nutrients contained in them, due to differences in losses and in the work involved in chewing and digestion. The use of the productive value is a decided step forward in the calculation of rations for feeding animals.

According to Kellner, 100 pounds of ether extract of roughages will produce 47.4 pounds of fat on a fattening animal; 100 pounds of starch will produce 24.8 pounds of fat; 100 pounds of protein will produce 24.8 pounds of fat; 100 pounds of crude fiber will produce 24.8 pounds of fat. These, then, are measures of the productive values of the constituents of feeds, and may be converted to therms, the measure used here.

If we assume that the digestible nutrients of all feeds have an equal value, we can calculate, from the above figures, that 100 pounds of a certain wheat straw should produce 10.4 pounds of fat. But by experiment, it was found that 100 pounds of this particular wheat straw produced only 2.1 pounds of fat. Hence the value calculated merely from the productive value of the nutrients without correction is utterly incorrect. On the other hand, the fat produced from cottonseed meal was found to be equal to that calculated. For this reason, it is plain that the digested constituents of wheat straw are quite different in productive value from the digested constituents of cottonseed meal, and correction must be made for the nature of the feed.

Other tests have given similar results, and proven conclusively that the digested nutrients of one feed may have a different value to the animal, pound for pound, from the digested nutrients of another feed.

It is quite possible that different animals may have different powers of utilizing the digested net nutrients of feeds, and that some animals may put on a different quantity of fat from that put on by the steers used by Kellner in ascertaining the productive values. This has indeed been found to be the case with pigs, which produce a larger amount of fat than the steers from the same digested nutrients; but the quantities of fat produced were in proportion to the productive values as determined on steers.

It is also possible that, for uses other than fattening, the value of a feed may not be the same as to its productive value, but the value would probably be in proportion to it. That is to say, the quantity of fat that the feed may produce on a fattening animal, may not represent the absolute value of the feed to animals for all other purposes, but its value for other purposes may be in proportion to the productive energy, or fat formed.

The productive value of a feed is the net energy for fattening expressed in therms per 100 pounds of feed. A therm is 1000 large calories. The productive energy is the measure of the value of that feed for supplying energy for productive purposes, such as the production of work, flesh, milk, eggs, or for maintenance of the animal body. After a feed is eaten, there are losses of energy in undigested food, and in fermentation. The process of digestion and assimilation also uses some energy, and there are some losses in the urine. The energy remaining after all these losses have been deducted, can be used by the animal for maintenance or for productive purposes if the amount fed is large enough. There are losses in utilizing the available energy, and these losses differ according to the use made of it. A larger proportion of the available energy can probably be used for maintenance than for fattening, so that the net energy of a feed for fattening is less than the net energy of the same feed for maintenance. It is desirable to adopt a single definite measure of the productive value of a feed, for use in comparing different feeds, for formulating feeding standards, and for other practical purposes. Kellner used as a measure the energy which is stored up in a fattening animal when the feed to be tested is added to a ration which exceeds slightly the maintenance requirements. The productive energy is thus the available energy measured in terms of energy and fat and flesh stored up by a fattening animal. The net energy measured by maintenance, by work, by milk, or by other methods, may be different from the net energy (or productive energy) measured by fattening, but should be in proportion to it. The distinction is necessary on account of the confusion caused by different values for net energy for different uses of the animal body. The productive energy, then, is the net energy for fattening when the feed is fed in a balanced ration.

Calculating the Productive Energy of a Feed

Coefficients for calculating the productive energy of various feeds are given in various bulletins of this Experiment Station (18, 19, 20, 22, 25). A table for the most important feeds is also given in this Bulletin (Table 10).

The calculation of the productive energy of a feed from its chemical composition and production coefficients is a simple matter. If percentage of each constituent of the feed is multiplied by the corresponding production coefficient, and the products totaled, the sum is approximately the productive energy in therms for 100 pounds of feed. The following is an example:

Alfalfa hay (below 30% crude fiber)

	Analysis	Coefficient	Product
Protein	14.8	.755	11.17
Fat	2.0	.812	1.62
Nitrogen-free extract	37.4	.776	29.02
Total			41.81
Fiber	29.1	—.152	—4.42
Productive value			37.39

The calculated productive energy of a number of feeds is given in Table 11.

VARIATIONS IN THE COMPOSITION OF FEEDS

It is well known that feeding stuffs vary in their content of protein, crude fiber, water, and other constituents, due to a number of conditions. On account of the impossibility of making chemical analyses of samples of every lot of feeding stuffs, it is frequently necessary to use an assumed composition. The average composition is frequently used for this purpose. For the purpose of making guaranties under feed laws, figures lower than the average are used, so as to allow a margin for variation in a feed. These are termed minimum guaranties. Such minimum guaranties are also used in calculating the composition to be guaranteed for mixtures, when the ingredients are of average quality and when chemical analyses are not frequently made of them. Average analyses are frequently used in discussing feeds or for formulating rations used in feeding experiments.

In connection with all these uses of average analyses, it is important to keep in mind the fact that the composition of the feed may vary from the average, sometimes to a considerable extent. The difference between therms of productive value secured for alfalfa hay in one laboratory from that secured in another may be partly due to differences in the composition of the hay used.

Variations in natural feeds may be due to the stage of growth at which they were gathered, the kind of seed planted, the soil, the seasonal conditions, the method of preparation, the conditions under which the feeds were prepared, and other factors. Manufactured feeds, including by-products, are affected by the composition of the materials from which they are made, and by the details of the process by which they are secured. Many by-products are mixtures from several machines, and their composition may be modified not only by changes in the operation of the machine, but also by the proportions of the products of the various machines which are mixed by the person in charge of the operation.

Some of the variations will be referred to in connection with the discussion of particular feeds.

Variations in particular constituents may be brought out by grouping the feeds according to their content of the constituent in question. Thus, in Table 1, are given the grouping of 586 samples of cottonseed meal collected from Sept. 1, 1930 to Sept. 1, 1931. The middle point of each group is given; thus, the group designated as 43.0 includes meals containing 42.76 to 43.25 per cent protein. It is noted that the protein in the 586 samples varies from 36.8 to 48.8 per cent with an average of 43.4 per cent. The greatest number of samples is in the protein group 43.26—43.75 with the mean 43.5 From this point the number decreases both ways. The same kind of distribution is observed with the other constituents. The percentage of samples in each group is also given.

Table 2 shows the grouping by various constituents of samples of wheat gray shorts, collected from Sept., 1930 to Sept., 1931. Only the middle points of these groups are given. A variation in the composition of the samples is to be observed similar to that of cottonseed meal. The percentage of protein varies from 14.8 to 20.2 per cent, the fat from 3.2 to 5.8, the crude fiber from 3.6 to 7.6, the nitrogen-free extract from 53.6 to 65.1, the water from 7.1 to 12.3, and the ash from 2.3 to 5.1. Wheat gray shorts containing more than 6.0 per cent crude fiber is considered to be misbranded, and to be really wheat brown shorts, but each season some samples of this kind appear on the market under the name of wheat gray shorts and for this reason are here included.

Similar tables could be prepared for other feeds but a mathematical expression of the variation is simpler and probably more accurate.

Mathematical Expression of Variation in Composition of Feeds

Tables similar to No. 1 and No. 2 would show the actual grouping of feeds according to their constituents but would take up considerable space and apply only to the samples listed. A condensed mathematical expression for variation is the standard deviation of the mean and of the percentile variation. The standard deviation was calculated by subtracting the average from the analyses, squaring the differences, dividing by the number of samples, and extracting the square root. It is assumed that a large number of samples, when grouped and plotted, would fall into a certain type of curve, the area of which represents the number of samples. This seems to be actually the case in many instances, but not always. From the calculated standard deviation and the average, or mean, of the analyses it is possible to calculate the proportion of samples which should fall into any part of the curve. In order to do this it is merely necessary to subtract the figure desired from the mean, divide the difference by the standard deviation, and read the desired proportion or percentage from a suitable table, giving the desired relative area of the portion of the curve.

Table 3 shows the percentage of samples which could be calculated to be in various groups by the use of the standard deviation and the average or mean. For example, the standard deviation of protein of cottonseed meal for 1930-31 (Table 4) is 1.36, and the average protein is 43.49 (Table 11). One per cent of the samples would be above 1.36 times 2.34 (Table 3) plus 43.49, and one per cent would be below 43.49 minus this product. Five per cent of the samples would be above 1.65 times 1.36 plus 43.49 per cent protein and five per cent would be below 43.49 - (1.65 times 1.36). The calculated number of samples in each group as given in the next to the last column, can be compared with the actual number found in the distribution of cottonseed meal according to its protein content, as given in the last column, and calculated from Table 1.

Variations in the Composition of Texas Feeds as Shown by the Standard Deviation

The standard deviations for some of the constituents of a number of feeds are given in Table 4 and the corresponding coefficients of variation in Table 5. No attempt was made to calculate the standard variation for all the feeds or all the constituents, but it is believed that the figures will give an idea of the variation in the different types of feeds.

As shown in Table 3, 67 per cent of the samples should come within the amount of the standard deviation of the average, while 33 per cent should come outside this limit. Thus, with the protein of alfalfa meal, 67 per cent of the samples should come within 1.50 per cent of the average (14.63%) per cent of protein and 33 per cent should contain either less than (14.63 - 1.50=13.13) per cent protein or more than (14.63+1.50=16.13) per cent protein. The crude fiber of alfalfa meal is more variable, as 33 per cent of the samples should deviate 3.76 above or below the average for crude fiber (29.38).

The standard deviations in Table 4 for protein and crude fiber usually range between 1 and 2 per cent but are of course low with feed low in these particular ingredients. The nitrogen-free extract is somewhat more variable.

In the period from 1924 to 1931, there is manifest a decided decrease in the standard deviation of the protein in cottonseed meal. from 2.28 to 1.36. This means that there is a decided decrease in the variation of the protein content of the samples on the market. This is evidently due to the success of the efforts of the manufacturers to make a more uniform product.

The standard deviation, expressed in percentage of the total feed, is necessarily low if the percentage of the ingredient in the feed is low. Somewhat different results are secured if the results are expressed in percentage of the ingredient present, as is done with the coefficients of variation in Table 5. From 1924 to 1931, the coefficient of variation of the protein in cottonseed meal is seen to decrease from 5.3 to 3.1 per cent. It is also much lower for protein in cottonseed meal in 1931 than for protein in any other feed.

The protein content of corn bran, corn silage, sorghum silage, and sudan grass hay is quite variable. The ether extract is more variable than the protein, but this is largely due to the much smaller percentages of ether extract generally present.

Crude fiber also has a high variability in many of the feeds. Nitrogen-free extract is usually the least variable in most feed though its variability is high for corn silage and sorghum silage.

Causes of the Variations in the Composition of Feeds

Some of the causes of the variations in the composition of feeds are discussed below.

Stage of growth. Young plants are soft and tender, and high in protein; as they become older, the fiber content of the stems and leaves increases and the content of protein decreases. Old plants have woody stems and leaves. There are thus great differences between the feeding value of the same plant at different stages of growth. This is shown by the series of analyses of bur clover at different

Table 1. Distribution of analyses of 43 per cent protein cottonseed meal, Sept. 1930 to Sept. 1931.

Protein			Fat			Crude fiber			Nitrogen-free extract			Water			Ash		
Percentage of protein	Number of samples	Per cent of samples	Percentage of fat	Number of samples	Per cent of samples	Percentage of fiber	Number of samples	Per cent of samples	% of nitrogen-free extract	Number of samples	Per cent of samples	Percentage of water	Number of samples	Per cent of samples	Percentage of ash	Number of samples	Per cent of samples
37.0	1	.17	4.5	1	.17	6.0	2	.34	24.0	4	.68	3.5	1	.17	4.38	0	0
37.5	0	0	5.0	0	0	6.5	0	0	24.5	4	.68	4.0	1	.17	4.63	20	3.41
38.0	0	0	5.5	9	1.54	7.0	2	.34	25.0	11	1.88	4.5	5	.85	4.88	83	14.16
38.5	1	.17	6.0	102	17.41	7.5	5	.85	25.5	38	6.48	5.0	20	3.41	5.12	163	27.82
39.0	1	.17	6.5	185	31.57	8.0	8	1.37	26.0	63	10.75	5.5	67	11.43	5.38	157	26.79
39.5	0	0	7.0	138	23.55	8.5	15	2.56	26.5	99	16.89	6.0	132	22.53	5.63	105	17.92
40.0	4	.68	7.5	65	11.09	9.0	25	4.27	27.0	120	20.48	6.5	149	25.43	5.88	35	5.97
40.5	6	1.02	8.0	40	6.83	9.5	55	9.39	27.5	123	20.99	7.0	120	20.48	6.12	13	2.22
41.0	11	1.88	8.5	19	3.24	10.0	73	12.46	28.0	71	12.12	7.5	75	12.80	6.38	9	1.54
41.5	28	4.78	9.0	12	2.05	10.5	102	17.41	28.5	33	5.63	8.0	13	2.22	6.63	0	0
42.0	50	8.53	9.5	11	1.88	11.0	106	18.09	29.0	9	1.54	8.5	2	.34	6.88	1	.17
42.5	67	11.43	10.0	0	0	11.5	80	13.65	29.5	8	1.37	9.0	1	.17	-----	-----	-----
43.0	79	13.48	10.5	3	.51	12.0	55	9.39	30.0	1	.17	-----	-----	-----	-----	-----	-----
43.5	119	20.31	11.0	1	.17	12.5	22	3.75	30.5	1	.17	-----	-----	-----	-----	-----	-----
44.0	78	13.31	-----	-----	-----	13.0	22	3.75	31.0	1	.17	-----	-----	-----	-----	-----	-----
44.5	57	9.73	-----	-----	-----	13.5	8	1.37	-----	-----	-----	-----	-----	-----	-----	-----	-----
45.0	41	7.00	-----	-----	-----	14.0	4	.68	-----	-----	-----	-----	-----	-----	-----	-----	-----
45.5	18	3.07	-----	-----	-----	14.5	0	0	-----	-----	-----	-----	-----	-----	-----	-----	-----
46.0	9	1.54	-----	-----	-----	15.0	2	.34	-----	-----	-----	-----	-----	-----	-----	-----	-----
46.5	7	1.19	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
47.0	4	.68	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
47.5	1	.17	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
48.0	1	.17	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
48.5	2	.34	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
49.0	1	.17	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Average 43.43	-----	-----	6.45	-----	-----	11.29	-----	-----	27.03	-----	-----	6.77	-----	-----	5.37	-----	-----

Table 2. Wheat gray shorts, Sept. 1930 to Sept. 1931.

Protein			Fat			Crude fiber			Nitrogen-free extract			Water			Ash		
Group per-cent-age of pro-tein	Num-ber of sam-ples	Per cent of sam-ples	Group per-cent-age of fat	Num-ber of sam-ples	Per cent of sam-ples	Group per-cent-age of crude fiber	Num-ber of sam-ples	Per cent of sam-ples	Group per-cent-age of nitro-gen-free extract	Num-ber of sam-ples	Per cent of sam-ples	Group per-cent-age of water	Num-ber of sam-ples	Per cent of sam-ples	Group per-cent-age of ash	Num-ber of sam-ples	Per cent of sam-ples
14.88	1	1.11	3.13	3	3.33	3.63	1	1.11	53.75	1	1.11	7.13	1	1.11	2.38	1	1.11
15.13	1	1.11	3.38	0	0	3.88	3	3.33	54.25	0	......	7.38	1	1.11	2.63	1	1.11
15.38	2	2.22	3.63	3	3.33	4.13	2	2.22	54.75	0	......	7.63	0	0	2.88	2	2.22
15.63	1	1.11	3.88	10	11.11	4.38	2	2.22	55.25	3	3.33	7.88	0	0	3.13	2	2.22
15.88	3	3.33	4.13	13	14.44	4.63	6	6.67	55.75	1	1.11	8.13	1	1.11	3.38	9	10.00
16.13	3	3.33	4.38	20	22.22	4.88	4	4.44	56.25	9	10.00	8.38	7	7.78	3.63	5	5.56
16.38	6	6.67	4.63	21	23.33	5.13	6	6.67	56.75	7	7.78	8.63	5	5.56	3.88	15	16.67
16.63	6	6.67	4.88	7	7.78	5.38	9	10.00	57.25	10	11.11	8.88	10	11.11	4.13	16	17.78
16.88	5	5.56	5.13	9	10.00	5.63	14	15.56	57.75	8	8.89	9.13	3	3.33	4.38	18	20.00
17.13	6	6.67	5.38	2	2.22	5.88	17	18.89	58.25	5	5.56	9.38	13	14.44	4.63	14	15.56
17.38	7	7.78	5.63	1	1.11	6.13	7	7.78	58.75	10	11.11	9.63	4	4.44	4.88	6	6.67
17.63	18	20.00	5.88	1	1.11	6.38	6	6.67	59.25	8	8.89	9.88	12	13.33	5.13	1	1.11
17.88	6	6.67	......	......	......	6.63	7	7.78	59.75	6	6.67	10.13	13	14.44	......	......	......
18.13	5	5.56	......	......	......	6.88	3	3.33	60.25	4	4.44	10.38	7	7.78	......	......	......
18.38	8	8.89	......	......	......	7.13	2	2.22	60.75	2	2.22	10.63	4	4.44	......	......	......
18.63	4	4.44	......	......	......	7.38	......	......	61.25	5	5.56	10.88	2	2.22	......	......	......
18.88	2	2.22	......	......	......	7.63	1	1.11	61.75	1	1.11	11.13	4	4.44	......	......	......
19.13	2	2.22	......	......	......	......	......	......	62.25	2	2.22	11.38	2	2.22	......	......	......
19.38	2	2.22	......	......	......	......	......	......	62.75	2	2.22	11.63	0	......	......	......	......
19.63	1	1.11	......	......	......	......	......	......	63.25	4	4.44	11.88	0	......	......	......	......
19.88	0	......	......	......	......	......	......	......	63.75	1	1.11	12.13	0	......	......	......	......
20.13	1	1.11	......	......	......	......	......	......	64.25	0	......	12.38	1	1.11	......	......	......
									64.75	0	......	......	......	......	......	......	......
									65.25	1	1.11	......	......	......	......	......	......
Total	90	......	......	90	......	......	90	......		90	......	......	90	......	......	90	......

Table 3. Percentage of samples within groups as measured by standard deviation, and above limit or below limit.

Limits	Percentage of samples in limit	Percentage of samples above limit	Protein in Cottonseed meal 586 samples
Between average and average plus 2.34 times standard deviation	49	1	1.5
Between average and average plus 1.96 times standard deviation	47.5	2.5	2.7
Between average and average plus 1.65 times standard deviation	45	5	5.3
Between average and average plus 1.28 times standard deviation	40	10	8.3
Between average and average plus 1.00 times standard deviation	34	16	15.3
Between average and average plus .67 times standard deviation	25	25	24.1
		below limits	
Between average and average minus .67 times standard deviation	25	25	28.8
Between average and average minus 1.00 times standard deviation	34	16	17.4
Between average and average minus 1.28 times standard deviation	40	10	8.9
Between average and average minus 1.65 times standard deviation	45	5	4.1
Between average and average minus 1.96 times standard deviation	47.5	2.5	2.2
Between average and average minus 2.34 times standard deviation	49	1	1.2
Between average +2.34 times standard deviation and average −2.34 times standard deviation	98	2	2.7
Between average +1.96 times standard deviation and average −1.96 times standard deviation	95	5	4.9
Between average +1.65 times standard dviation and average −1.65 times standard deviation	90	10	9.4
Between average +1.28 times standard deviation and average −1.28 times standard deviation	80	20	17.2
Between average +1.00 times standard deviation and average −1.00 times standard deviation	67	33	32.7
Between average + .67 times standard deviation and average − .67 times standard deviation	50	50	53.9

Table 4. Standard deviation of constituents of important feeds.

	Number of samples	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash
Alfalfa meal	72	1.50	.35	3.76	2.77	1.81	.64
Barley chops	280	1.26	.48	1.02	1.69	----	----
Blood meal	12	----	.89	1.27	1.52	----	----
Beet pulp, dried	25	1.04	.24	5.43	2.61	1.83	----
Brewers' dried grains	26	2.27	.64	2.27	2.91	----	----
Cocoanut oil cake or meal	39	1.55	----	----	----	----	----
Whole-pressed cottonseed	142	1.82	1.83	2.02	2.08	----	----
Corn bran	319	1.58	2.24	2.90	3.62	----	----
Corn chops	899	.70	.56	.47	.65	1.77	----
Corn chops, ear	83	.97	.50	1.95	2.09	----	----
Chopped corn in shuck	210	.81	.48	1.71	1.90	1.64	----
Corn gluten feed	13	1.56	.69	.65	2.65	----	----
Corn silage	17	.56	.17	1.37	2.94	4.75	.29
43% protein cottonseed cake, Sept. 1, 1924 to Sept. 1, 1925	196	2.28	1.04	1.65	1.61	----	----
43% protein cottonseed cake, Sept. 1, 1925 to Sept. 1, 1926	168	2.59	.95	1.62	1.63	----	----
43% protein cottonseed cake, Sept. 1, 1926 to Sept. 1, 1927	135	1.89	.99	1.75	1.31	----	----
43% protein cottonseed meal, Sept. 1, 1924 to Sept. 1, 1925	472	2.09	1.29	1.50	1.53	----	----
43% protein cottonseed meal, Sept. 1, 1925 to Sept. 1, 1926	411	2.17	1.49	2.04	1.68	----	----
43% protein cottonseed meal, Sept. 1, 1926 to Sept. 1, 1927	424	1.70	1.34	1.45	1.46	----	----
43% protein cottonseed meal, Sept. 1, 1930 to Sept. 1, 1931	----	1.36	.87	1.26	.98	.75	.36
Cottonseed cake, daily analyses, West Texas mill	177	1.42	----	----	----	----	----
Cottonseed cake, South Texas mill, day and night analyses	279	1.96	.50	----	----	----	----
Cottonseed cake, Northwest Texas mill	177	1.68	.67	----	----	----	----
Feterita chops	16	1.07	.38	.29	2.04	----	----
Hominy feed	147	.99	1.61	1.84	3.31	----	----
Kafir chops	39	1.18	.36	----	2.02	----	----
Kafir chops in 1927	37	1.30	.36	.35	1.64	----	----
Kafir head chops	8	.56	.35	----	----	----	----
Linseed meal	22	1.61	.61	.67	1.35	1.05	.49
Milo chops	236	.97	.48	.54	1.69	----	----
Milo head chops	88	.96	.37	.67	1.67	----	----
Rice bran	122	1.04	1.74	2.71	3.34	1.44	.57
Rice bran, 1929–31	27	.91	1.60	1.56	2.00	1.27	1.64
Rice polish	55	.99	1.87	.77	3.48	.70	.74
Sorghum silage	33	.49	.19	2.02	4.42	3.39	1.09
Sudan grass hay	23	2.19	.33	2.20	3.48	1.18	1.62
Wheat bran and screenings	458	1.02	.48	1.02	2.17	1.63	.75
Wheat gray shorts, Sept. 1, 1924 to Sept. 1, 1925	120	.98	.58	1.04	2.26	----	----
Wheat gray shorts, Sept. 1, 1925 to Sept. 1, 1926	115	1.25	.60	1.22	2.15	----	----
Wheat gray shorts, Sept. 1, 1926 to Sept. 1, 1927	104	1.47	.68	.96	2.61	1.04	.63
Wheat gray shorts, 1930–31	89	1.04	.51	.81	1.55	.91	.55

Table 5. Coefficients of variation in Texas feeding stuffs.

	Number of samples	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash
Alfalfa meal	72	10.3	19.6	12.8	7.5	22.0	7.6
Barley chops	280	10.5	22.5	16.1	2.6	——	——
Blood meal	12	——	——	——	——	——	——
Beet pulp, dried	25	11.6	39.3	27.1	4.5	21.5	——
Brewers' dried grains	26	9.5	10.2	13.0	7.0	——	——
Cocoanut oil cake or meal	39	7.8	——	——	——	——	——
Whole-pressed cottonseed	142	6.7	26.6	8.1	7.1	——	——
Corn bran	319	16.4	36.9	29.9	5.8	——	——
Corn chops	899	7.0	14.1	19.1	1.0	15.6	——
Corn chops, ear	83	10.8	14.6	26.0	3.1	——	——
Chopped corn in shuck	210	9.5	14.8	16.0	2.9	16.4	——
Corn gluten feed	13	6.0	29.9	8.5	5.1	——	——
Corn silage	17	24.5	23.6	17.7	17.8	6.7	14.1
43% protein cottonseed cake, Sept. 1, 1924 to Sept. 1, 1925	196	5.3	14.7	16.1	5.8	——	——
43% protein cottonseed cake, Sept. 1, 1925 to Sept. 1, 1926	168	6.1	14.3	15.4	6.0	——	——
43% protein cottonseed cake, Sept. 1, 1926 to Sept. 1, 1927	135	4.3	14.0	18.1	4.8	——	——
43% protein cottonseed meal, Sept. 1, 1924 to Sept. 1, 1925	472	4.9	17.2	13.9	5.7	——	——
43% protein cottonseed meal, Sept. 1, 1925 to Sept. 1, 1926	411	5.1	19.4	18.2	6.2	——	——
43% protein cottonseed meal, Sept. 1, 1926 to Sept. 1, 1927	424	3.9	20.0	14.6	5.4	——	——
43% protein cottonseed meal, Sept. 1, 1930 to Sept. 1, 1931		3.1	12.6	11.2	3.6	11.6	6.7
Cottonseed cake, daily analyses, West Texas mill	177	3.3	——	——	——	——	——
Cottonseed cake, daily and night analyses, South Texas mill	279	4.5	9.5	——	——	——	——
Cottonseed cake, Northwest Texas mill	177	3.9	12.8	——	——	——	——
Feterita chops	16	8.7	12.5	13.4	2.9	——	——
Hominy feed	147	8.8	21.8	29.3	5.3	——	——
Kafir chops	39	11.1	12.0	——	2.8	——	——
Kafir chops in 1927	37	12.2	12.7	14.7	2.3	——	——
Kafir head chops	8	5.5	13.3	——	——	——	——
Linseed meal	22	4.6	9.1	7.8	3.8	12.8	8.9
Milo chops	236	8.9	17.3	21.8	2.4	——	——
Milo head chops	88	9.6	15.0	9.7	2.5	——	——
Rice bran, all	122	8.0	13.1	22.2	8.1	16.0	5.3
Rice bran, 1929-31	27	6.8	11.3	11.4	5.1	17.4	13.4
Rice polish	55	7.9	16.2	24.0	6.1	7.1	12.3
Sorghum silage	33	24.4	24.7	26.1	25.6	——	41.1
Sudan grass hay	23	25.5	18.3	——	8.0	13.9	20.0
Wheat bran and screenings	458	6.2	12.1	10.6	3.6	15.8	12.4
Wheat gray shorts, Sept. 1, 1924 to Sept. 1, 1925	120	5.5	12.2	17.9	3.9	——	——
Wheat gray shorts, Sept. 1, 1925 to Sept. 1, 1926	115	6.8	13.2	20.9	3.8	——	——
Wheat gray shorts, Sept. 1, 1926 to Sept. 1, 1927	104	8.3	15.0	17.6	4.5	10.8	15.6
Wheat gray shorts, 1930-31	89	6.0	11.9	14.4	2.6	9.4	12.8

stages of growth given in Table 11, and also by the analyses of prairie grass from Harris county, also given in Table 11.

Plants such as corn, milo, or kafir near maturity develop a large proportion of grain low in crude fiber. If the entire plant is considered, there would be a decrease in crude fiber near maturity. The crude fiber increases in the stalks and leaves if they are taken separately.

Soil and Season. Soil and season affect the composition of feeding stuffs. As shown with corn (21), the protein content of the corn varies with different localities. There is a correlation coefficient of $-.576 \pm .072$ between the percentage of protein in the grain and the rainfall, January to July. The composition of cottonseed varies with the locality in which it is grown, and also, apparently, with the variety(9). Different selections of seed of the same variety of cotton also vary (19), so that it is possible to breed varieties of cotton seed high in fat. The soil and season cause variations in the composition of other plants.

Method of preparation. The preparation or storage of feeds affects their chemical composition. The amount of water left in the feed decreases the constituents in direct proportion to the quantity of water. A decrease in water content increases the feeding value of the same feed. Loss of leaves of alfalfa or other plants in drying results in a lower content of protein and a higher content of crude fiber, with a lower feeding value, compared with the feed containing all the leaves. When a feed heats, some of the easily-digested materials are oxidized and partly lost. Exposure to rain may allow some of the soluble constituents of the feed to be washed out.

Methods of manufacturing. Many commercial feeds are by-products from the manufacture of more valuable foods or feed. For example, wheat bran, wheat gray shorts, and wheat brown shorts are by-products from the manufacture of wheat flour. Cottonseed meal is a by-product from the manufacture of oil from cottonseed. Variations in the procedure followed by the manufacturer affect the composition of the by-product. Improvements in methods for the extraction of oil from cottonseed have decreased the average content of oil in Texas cottonseed meal from 9.73 per cent in 1907 to 7.5 per cent in 1931. Wheat millers who take out part of the floury material, or who increase the bran particles, will produce wheat brown shorts instead of wheat gray shorts. The composition of the wheat brown shorts will also depend upon the proportion of the wheat which goes into flour. Other processes in the control of the manufacturer affect the composition of the by-product. The composition of the raw material also affects the composition of the by-product.

Effect of Variation in Composition of the Feed upon its Feeding Value

The composition of feeds as discussed in this Bulletin is related more closely to productive energy and digestible protein than to the minerals or vitamins, which are not discussed. The digestible protein of a given feed is almost in direct proportion to the protein content, though the percentage of protein digested is usually somewhat higher for the feed high in protein and somewhat lower for the feed low in protein. The digestion coefficients also vary from the average, as already shown (18,19). That is, the feed high in protein is likely to be of higher quality than the average. Consequently, a greater percentage of the protein is digested from it than from an average feed. On the other hand, a feed much lower than the average in protein is likely to be of inferior quality to the average; consequently the percentage of protein digested from it is less than the average.

Increases in the water and in the ash of feeds tend to decrease both the digestible protein and the productive energy of the feed. A given concentrate high in protein may or may not have a higher productive energy than another lot of the same feed low in protein. However, a roughage high in protein is likely also to have a higher productive energy than the same kind of feed low in protein. A feed high in crude fiber is likely to have a lower content of protein and to furnish less productive energy, than the same kind of feed low in crude fiber.

In order to secure some information regarding variations in productive energy, the productive energy of a number of samples of feeds is calculated from the chemical composition and the average production coefficients. The analyses used for corn chop, wheat bran and screenings, and cottonseed meal were selected at random from large numbers of recent analyses. The other analyses represent all the analyses of a group.

The results of the calculations are given in Table 6. Decidedly wide variations are found to occur in the calculated productive energy of various samples of alfalfa hay, corn silage, rice bran, and sorghum fodder. The poorest samples of alfalfa hay and the poorest sorghum fodder have less than two-thirds the productive energy of the best samples. The coefficients of variation is 22.0 per cent for the productive energy of corn silage, and about 12.5 for alfalfa hay and sorghum hay or fodder.

The samples of Bermuda hay, cottonseed meal, corn chops, and wheat bran examined were much less variable in productive energy than alfalfa hay, corn silage, rice bran, and sorghum fodder. The coefficient of variation varies from 1.2 for corn chops and wheat bran to 5.48 for rice bran. It is quite possible that the samples of Bermuda hay did not represent a sufficiently wide range of conditions and that Bermuda hay is much more variable than here shown.

The standard deviations and coefficients of variation of some of the constituents which, it was thought, might be most closely related to the productive energy, are given in Table 6. The standard deviations of crude fiber and of productive energy are quite close together in alfalfa hay, Bermuda hay, and wheat bran, and are related in sorghum fodder, tho less closely than with the other feeds. The productive energy in corn chops has a higher standard deviation than the protein and a lower standard deviation than dry matter in corn silage. The coefficients of variation of the productive energy are less closely related to those of the other constituents, than are the standard deviations.

Table 6. Variation of productive energy of feeds compared with that of other constituents.

	Alfalfa hay	Bermuda hay	Cotton-seed meal	Corn chop	Corn silage	Rice bran	Sorghum fodder	Wheat bran
Productive energy, therms, per 100 pounds average	38.4	31.3	74.7	87.1	16.0	30.0	34.9	57.6
Maximum	46.8	33.7	79.5	84.3	23.0	79.6	42.5	59.5
Minimum	28.2	29.7	71.0	88.9	11.7	57.0	25.5	55.9
Standard deviation—productive energy	4.81	1.08	2.22	1.06	3.5	5.78	3.83	.8
Protein	——	——	1.50	.58	——	——	——	——
Crude fiber	5.15	1.17	1.49	——	——	1.55	5.40	.7
Dry matter	——	——	——	——	5.0	——	——	——
Nitrogen-free extract	——	——	——	——	——	2.06	——	——
Coefficient of variation—productive energy	12.5	3.9	3.0	1.2	22.0	8.0	12.7	1.4
Protein	——	——	3.5	5.9	——	——	——	——
Crude fiber	18.7	4.4	14.0	——	——	11.4	27.5	4.4
Dry matter	——	——	——	——	16.7	——	——	——
Nitrogen-free extract	——	——	——	——	——	5.3	——	——
Number of samples	23	12	30	24	17	27	22	24
Digestible protein—average	——	——	35.5	——	1.2	——	——	——
Maximum	——	——	37.7	——	.7	——	——	——
Minimum	——	——	33.2	——	1.7	——	——	——

By using the standard deviations for similar feeds in Table 4, and comparing with Table 6, it is possible to make an estimate of the variability of the productive energy of various feeds given in the table. The standard deviation of the crude fiber in alfalfa meal in Table 4 is less than that of the group of alfalfa hay used for calculating productive energy in Table 6. It may therefore be assumed that the productive energy of alfalfa meal is less variable than that of this particular group of alfalfa hays. The crude fiber (Table 4), of barley chops has a higher standard deviation than the crude fiber of wheat bran in Table 6; we assume that barley chops are more variable in productive energy than the group of wheat brans used in this table. Similar comparisons would make possible the statement that wheat bran and screenings are more variable in productive energy than the wheat bran of Table 6; so also is corn chops.

Differences Due to Variation in Production Coefficients

The foregoing discussion was based upon energy productive values calculated from the energy production coefficients. Since these are averages based upon average digestion coefficients, and since the individual digestion coefficients also vary from this average, sometimes to a considerable extent (18, 19, 22), it is seen that the actual variations in productive energy are somewhat larger than was found in the preceding section. These variations are intimately connected with the chemical composition of the feed. Thus chemical analyses, to show the exact chemical character of the feed used, are essential in any work dealing with the feeding values of feed stuffs.

Cost of Digestible Protein, Productive Energy, and Bulk in Feeds

The three most important things purchased in feed are the digestible protein, the productive energy, and the bulk, or volume. While minerals and vitamins in the feed are valuable and cannot be disregarded, it is not at the present time practical to calculate their price or money value. Digestible protein and productive energy are important in all feeds. Bulk is important only in bulky feeds; it acts to depress the price paid for nutrients in bulky feeds when purchased. This effect is due chiefly to the high cost of transportation per unit of feeding value in bulky feeds.

A method sometimes used for calculating the cost of protein is simply to divide the price per ton by the number of pounds of protein in a ton. This procedure is incorrect, as it ignores the value of the productive energy contained in the constituents other than protein. The cost of the total digestible nutrients is sometimes calculated in the same way, the protein being ignored. If the cost of protein and of digestible nutrients in cottonseed meal is calculated in this way, and then calculated back to the value of cottonseed meal, it naturally comes out twice the original cost. If 12 oranges and 20 apples cost $1.20, the oranges would not cost $1.20 divided by 12 or 10c each and the apples $1.20 divided by 20 or 6c each (which would be the method of calculation for the cost of protein mentioned above), but the oranges might cost 5c each and the apples 3c each. With two equations, the cost of protein and of productive energy can be calculated by elementary methods of algebra.

In the case of concentrates, the cost of digestible protein and of productive energy can be calculated for pairs of feeds, one high in protein, the other low in protein, by the method given in Bulletin 323 of this Station (17). If the following are assumed:

x=cost of digestible protein in cents per pound
y=cost of productive energy in cents per therm
a=price of concentrated feed (A) low in protein, in cents per 100 pounds
b=price of concentrated feed (B) high in protein, in cents per 100 pounds
p=pounds digestible protein in 100 pounds of feed A
n=pounds digestible protein in 100 pounds of feed B
t=therms of productive energy in 100 pounds of feed A
c=therms of productive energy in 100 pounds of feed B

then

$$px+ty=a \quad \text{(Equation 1)}$$

$$nx+cy=b \quad \text{(Equation 2)}$$

Solving for x and y, we have

$$x=\frac{tb-ca}{nt-pc} \quad \text{(Equation 3)}$$

$$y=\frac{na-pb}{nt-pc} \quad \text{(Equation 4)}$$

In the above equations, the fraction $\frac{1}{nt-pc}$ is a constant for any two feeds of a given composition. It may be designated by k.

$$k=\frac{1}{nt-pc} \quad \text{(Equation 5)}$$

The calculation may be then simplified if it is calculated for these feeds. The equations for x and y then become

$$x=(tb-ca)k \quad \text{(Equation 6)}$$

$$y=(na-pb)k \quad \text{(Equation 7)}$$

Since corn and cottonseed meal are two of the most easily secured well-known feeds in the South, their prices may be used in calculating the cost of digestible protein and of productive energy. Similarly, corn and cottonseed meal or corn and linseed meal may be used in the North.

Using the average composition given in Table 11 for Texas corn chops ($p = 6.4$, $t = 85.8$) and 43 per cent protein cottonseed meal ($n = 35.9$, $c = 74.9$), the value of k would be .000384.

With the composition given in Table 11 for corn chops and for 34 per cent protein linseed meal ($n = 29.4$, $c = 77.6$), the value of k would be .000494.

If we assume corn chops to cost \$23.00 a ton (or a = 115 cents a hundred) and 43 per cent protein cottonseed meal to cost \$24.00 a ton (or b = 120 cents a hundred) and the average composition given in Table 11 be used, the average values of a, b, p, n, t, c would be as given above. Solving equations 5 and 6 with these values,

$$x = (85.8 \times 120 - 74.9 \times 115) \quad .000384$$
$$y = (35.9 \times 120 - 6.4 \times 120) \quad .000384$$

we find the cost of digestible protein and productive energy for this pair of feeds to be

x = 0.646 cents a pound of digestible protein
y = 1.290 cents a therm of productive energy

These prices could then be used in connection with the digestible protein and productive energy given in Table 11 for the purpose of calculating the comparative values of other feeds when corn chops and cottonseed meal are selling at the prices specified. (See Table 7.) Equation 1 would be used ($px + ty = a$), in which p would be the percentage of digestible protein in the feed, t the therms of energy in 100 pounds, x the price of digestible protein, and y the price of therms energy.

For example, taking rice bran and using the average composition in Table 11, digestible protein p is equal to 8.9, and therms of productive energy t is equal to 69.9.

Equation 1 ($8.9 \times .646 + 69.9 \times 1.290 = 95.92$) gives the relative value of rice bran in cents per hundred. Calculations for other feeds are given in Table 7. For other prices of corn chops and cottonseed meal, the cost of digestible protein and productive energy would of course be different.

When Protein Costs Nothing

If protein is assumed to have no money cost, equation 1 becomes

$$ty = a \quad \text{(Equation 8)}$$

$$y = \frac{a}{t} \quad \text{(Equation 9)}$$

With corn chops at \$20.00 a ton, a = 100 and t = 85.8; y then becomes $100 \div 85.8 = 1.166$ cents a pound for productive energy. The energy value of cottonseed meal would be $cy = b$, and since $c = 74.9$, cottonseed meal would be worth $74.9 \times 1.166 = 84.333$ cents a hundred, or \$17.47 a ton. Therefore if cottonseed meal sells for \$0.87 a hundred or less when corn is \$1.00 a hundred, no price is being secured for the digestible protein; it is thrown in free with the energy.

Prices of Feeds as Related to Prices of Digestible Protein and Productive Energy, and to Bulk

It was shown in Bulletin 323 that the selling prices of a number of concentrated feeds were closely related to the values calculated from the cost of digestible protein and of productive energy at any particuler

Table 7. Valuation of digestible protein and productive energy in feeds when corn sells for $23.00 a ton and 43 per cent protein cottonseed meal for $24.00.

	Value per ton dollars	Digestible protein per cent	Productive energy therms in 100 pounds	Value of digestible protein in 100 pounds Cents	Value of productive energy in 100 pounds Cents	Combined value of digestible protein and productive value in 100 pounds Cents
Corn chops (assumed)	$23.00	6.4	85.8	-------	-------	-------
Cottonseed meal (assumed)	24.00	35.9	74.9	-------	-------	-------
Cost of digestible protein .646 cents a pound; productive energy 1.290 cents						
Alfalfa hay, average	11.96	9.7	41.5	6.27	53.54	59.81
Barley chops, average	20.44	9.6	74.4	6.20	95.98	102.18
Bean meal, average	23.69	20.4	81.6	13.18	105.26	118.44
Ear corn chops, average	19.98	5.5	74.7	3.55	96.36	99.91
Kafir head chops, average	20.29	7.1	75.1	4.59	96.88	101.47
Linseed meal, average	23.82	29.4	77.6	18.99	100.10	119.09
Milo chops, average	22.92	8.1	84.8	5.23	109.39	114.62
Oats, white, all	19.87	10.0	72.0	6.46	92.88	99.34
Oat meal mill by-product, average	8.71	3.7	31.9	2.39	41.15	43.54
Rice bran	19.18	8.9	69.9	5.75	90.17	95.92
Rice polish	24.56	9.0	90.7	5.81	117.00	122.81
Wheat bran	16.37	13.3	56.8	8.59	73.27	81.86
Wheat gray shorts	21.16	14.6	74.7	9.43	96.36	105.79
Wheat brown shorts	18.60	14.8	64.7	9.56	83.46	93.02

time. Allowance must of course be made for variations due to local conditions and to fluctuations in prices. Feed such as oats, wheat bran, alfalfa meal, cottonseed hulls and prairie hay, and any hay or fodder had prices higher than the calculated values. This difference may be due partly to the bulk, or volume, partly to other values. The difference between the price of the nutrients and the price of the feed may be taken as the price of the bulk or other items of feeding value. The purchaser can then decide whether or not the bulk is worth the difference, and which is the cheapest feed.

In Bulletin 323, we take as a measure of the bulk, or volume, in 100 pounds, the difference between the sum of the productive energy (E) and moisture (M) in 100 pounds.

$$\text{Bulk } d = 100 - (E + M) \qquad \text{(Equation 10)}$$

If w is the cost of one pound of bulk, then

$$wd = s - p \qquad \text{(Equation 11)}$$

$$w = \frac{s - p}{d} \qquad \text{(Equation 12)}$$

s = price of the bulky feed in cents per hundred, and

p = price of the digestible protein and productive energy in cents per hundred (Equation 1) calculated from concentrates.

An illustration of the method used for estimating the price of bulk is as follows:

If alfalfa hay selling at $16.00 a ton, with corn at $23.00 and cottonseed meal at $24.00, is assumed to have the average composition shown in Table 11, it would contain 11.0 per cent digestible protein and 37.4 therms productive energy in 100 pounds. Using the values for digestible protein and productive energy calculated above for cottonseed meal, the value of these in alfalfa hay would be

$$p = ax + ty$$

The bulk in 100 pounds would be

$$d = 100 - 37.4 \text{ (productive energy)} - 8.4 \text{ (water)} = 54.2$$

Using equation 10, s = 80 (cents a hundred pounds)

$$y = 1.290 \quad x = .646 \quad p = ax + ty \quad p = 37.4 \times 1.29 + 11.0 \times .646 = 60$$

$$s - p = 80 - 60 = 20$$

$$w = \frac{s - p}{d} = \frac{20}{54.2} = 0.369 \text{ cents a pound of bulk}$$

The approximate cost of bulk in other bulky feeds could be calculated in the same way. Other values than bulk might, of course, be present.

MINERAL MATTER

The full grown animal does not need large amounts of mineral material, but growing animals require certain quantities of mineral matter for the production of bone, and also for storing away as part of the constituents of their flesh. Animals giving milk require mineral matter for the purpose of milk formation. The most important constituents of the ash or mineral of plants are phosphoric acid and lime.

Growing animals which do not receive sufficient lime and phosphoric acid in their food, suffer from the deficiency. The bones become weak, the limbs and spinal column bend, and the animal does not develop properly or may have other troubles. Pigs may suffer in this way because unless tankage is fed, the food ordinarily fed in many cases does not contain a sufficient quantity of lime.

In certain restricted localities, the food usually eaten by animals does not contain sufficient lime, and the bones of the animal are poorly developed. In addition, the animals suffer from various diseases, which diseases, on investigation, have been found due to the deficiency of lime or phosphoric acid in the feed fed. A deficiency of minerals is sometimes manifested by a tendency of the animals to gnaw bones, wood, leather, labels on tin cans, etc.

A deficiency of lime only in the ration may be supplied by the use of limestone, oyster shell, or air-slaked lime.

Lime and phosphoric acid together may be supplied by means of ground bone, or other phosphatic materials.

Salt is found in digestive juices, and a certain quantity of salt appears to be very necessary to the welfare of animals. A moderate amount of salt increases the retention of protein by the animal body, which results in an increased production of flesh. Steers of average weight require about one ounce of salt per day, and horses from one-half to one ounce. Steers on a fattening ration may require as much as two ounces of salt per day or even three ounces of salt per day. An excess of salt is undesirable.

MAINTENANCE RATION

The maintenance ration is a ration which provides for the bodily needs of the animal, without supplying any excess to be used for fat, milk, work, or other productive purposes. A ration which maintains the weight of a full-grown animal may be sufficient for maintenance, but an animal may maintain weight and be losing fat at the same time. A ration which maintains the weight of a growing animal is likely not to be sufficient for maintenance, and the animal is likely to be using some of its stored fat for maintenance purposes.

Horses may be placed upon a maintenance ration during periods of idleness. Cattle may be placed upon a maintenance ration between the end of the fattening period and the time of sale; also during periods before the fattening period begins, if, for any reason, it is desirable to delay the fattening process. Breeding stock may at times be placed on a maintenance ration.

The maintenance requirement is also a basis for the other rations, since that portion of the ration which may be used for productive purposes is the excess over maintenance.

Young animals cannot normally be placed upon maintenance rations, since growth is a normal condition of the young, and the maintenance ration does not allow for growth.

The amount of food required for maintenance depends, to a considerable extent, upon the temperature. The maintenance ration is usually based upon a temperature of 64° F. At this temperature, a considerable portion of the needs of the animal is for heat to keep up the body temperature. As the temperature of the surroundings rises, less heat is required, until at 95° F. no heat from the food is needed to keep up the body temperature. As the temperature becomes lower than 64° F., on which the maintenance ration is based, the requirements of the animal increase, and a decided decrease in the temperature of the surroundings may cause a great increase in maintenance requirements.

This explains the great suffering which comes among the range animals when snow decreases available forage, and at the same time increases the requirements of the animal.

The temperature of the drinking water has the same effect. Its temperature must be raised to that of the animal body. If an ox drinks his usual quantity of water, at a temperature of 41° F., the amount of feed required to heat this water to body temperature is equal to about 25 per cent of his maintenance ration. That is to say, the needs of the animal for maintenance are increased 25 per cent. Animals which are kept at a comfortable temperature, but drink cold water, thus need additional food for maintenance, for the purpose of warming this water.

A fat animal requires more food for maintenance, in proportion to its weight, than a thin animal.

THE FATTENING RATION

The gain in weight during the process of fattening is largely fat in the chemical sense. The nutritive ratio of the gain of full-grown animals is about 1:20; that is, there is almost 1 pound of protein gained for every 20 pounds of non-protein (including fat x 2.25). On an average, the gain in weight is two-thirds fat, the remainder being water, protein, ash, etc. Growing animals put on more protein (flesh) than full-grown animals, and have greater requirements for protein.

Only the excess of food over the quantity necessary for maintenance can be used for the increase in fat of the fattening animal. Anything which increases or decreases the quantity of food required for maintenance will thus decrease or increase the quantity available for gain in fat.

Animals use energy in the processes of digestion, which is finally liberated as heat. This heat may be used for warming the animal body, if needed for that purpose. Since fattening animals digest a larger ration than animals on maintenance, they have a larger excess of heat resulting from digestion of the larger ration, and may be kept in quarters having a lower temperature, without an increase in maintenance requirements or need for extra food.

In warm weather, fattening animals may have trouble in disposing of the excess of heat produced in the processes of digestion and assimilation. They then instinctively consume less food, which explains why the fattening process may not be successful, as a rule, during hot weather. The high energy ration produces an excess of heat, which makes the animal uncomfortable and decreases his appetite.

On the other hand, if the fattening animal is exposed to too cold a temperature, or has too cold drinking water, his requirements for maintenance will be increased, less food will be available for fattening and the result will show in a decrease in the gain of weight. In cold climates, it has been found desirable to warm the drinking water, especially for hogs.

The fatter the animal, the more food is required for maintenance, and the less the proportion of the ration that is available for fat. Hence the cost of the gain increases with the fatness of the animal.

As has just been said, only the excess of food over that required for maintenance can be used for fattening. The larger this excess within the limit of the ability of the animal to utilize it, the larger is the proportion of the ration which may be used for fattening, and the less is the cost of the gain in weight per unit of food.

Thus it is usually more economical to feed a heavy ration to a given animal than a light ration. The production of fat is proportionally greater. For example, if a steer whose maintenance requirements are 6.0 therms of productive energy, is fed a ration equal to 8 therms of productive energy, only 2 therms are available for production, and here only one-fourth of the ration can produce fat. But if this animal is fed and able to use 12 therms of productive value, the amount in excess of the maintenance requirement would be 6 therms and thus one-half of the ration is used in production of fat. Thus the gain in fat produced by the second ration would be three times the gain by the first, and the cost of the fat produced by the first ration would be nearly twice the cost of that produced by the second. In other words, the cost of fattening may be reduced by feeding a ration which is as heavy as the animal can profitably utilize. Too heavy a ration, on the other hand, reduces the production of fat, since the excess interferes with the normal processes of the animal and makes the fattening process less successful.

The nutritive ratio is usually considered to be of considerable importance in calculating rations for feeding. This ratio may vary between wide limits without affecting the process of fattening. The nutritive ratio should not be wider than 1 to 10 for cattle or 1 to 12 for swine, because in such a case the digestibility of the food is lowered. It should not be narrower than 1 to 4, because such excess of protein *is not good for the welfare of the body. Between these limits, the nutritive* ratio is not of great nutritive importance, though it may be important in affecting the cost of the feed.

As protein is expensive, it is usually better to figure the ration for the lowest quantity of protein. In Texas, however, when the price of cottonseed meal is low, one should use narrow nutritive rations and more protein for cattle, sheep, and other ruminants.

When the total quantity of protein fed is correct, the nutritive ratio is taken care of automatically.

The quantity of fat fed is not of importance, provided that it does not exceed one pound of fat per thousand pounds of live weight per day. Any excess over this quantity is liable to cause digestive disturbances and so interfere with fattening. Pigs can use larger quantities of fat than this amount, but even with these animals the quantity of fat should not exceed one and a half pounds per 1000 pounds of live weight. This is the reason why it is advisable to feed only moderate quantities of feeds high in fat, such as cotton seed, soy beans, or peanuts.

WORKING ANIMALS

The energy used for work comes directly or indirectly from the food. Food or body material is oxidized in the animal whenever work is done, just as coal is burned in an engine. The working animal should be fed such quantity of food as will maintain the body, and, in addition, the quantity that will supply the necessary energy for the quantity of work required. The ration must, therefore, depend on the amount and kind of work.

As already stated, only the excess of food over that required for maintenance can be used for the production of fat. If insufficient food is furnished to working animals, they consume the substance of their bodies for the purpose of producing energy and become thin. Any animal when working, needs a heavier ration than during periods of idleness.

Animals vary considerably in their capacities to do work. The conformation of the animal determines how much energy he will have to use to do a particular kind of work. One type of animal is better adapted to a particular kind of work than another type. Those animals adapted to the work can use the energy of the food to better advantage than the other types not so well adapted.

GROWING ANIMALS

Growth is a normal condition for a young animal. It is not possible to put a young animal on such a maintenance diet that it will stop growing and will neither lose nor gain fat. The growing animal should secure enough food to provide for the proper growth of the flesh and enough mineral matter for the bony skeleton. A young animal gains more weight in proportion than an older animal, even on a fattening ration. Young animals do not require less food for maintenance, but they eat more in proportion to their weight, and they are thus able to store a greater proportion of the food eaten. It follows that the greatest gain in weight for the quantity of food eaten occurs with the younger animal, and the gain requires more food as the animal grows older. This is shown by the following table, giving the quantity of food required for 100 pounds of gain at different weights in certain experiments:

Pigs

Weight	Pounds food eaten per 100 lbs. gain
Below 100 lbs.	300
100 to 150	360
200 to 250	420
250 to 300	450

Similar results could be given for other animals.

The young animals intended to be fattened should be fed more liberally than those to be used for milk or work. Young animals are very sensitive to injurious influences and they require careful feeding, good food, and protection from injurious influences. The food should be furnished often and regularly, clean vessels should be used for drinking water, and stalls should be dry and well ventilated. The animal should be supplied with clean dry bedding. Cold, wet, and drafts should be avoided.

MILK COWS

Milk cows are fed for the purpose of producing milk or butter fat. As is the case with other animals, only the excess of feed over that required for maintenance can be used for productive purposes. Therefore, the greater the quantity of the excess, within the capacity of the animal to utilize it, the greater is the return per unit of feed stuff consumed. In other words, heavy rations, within the capacity of the animal, are more profitable than light rations. Furthermore, animals that can utilize heavy rations and can work them into milk, are more profitable than animals that can utilize only a small excess over the maintenance ration.

There is a great difference in the capacity of individual cows to utilize the productive values of feed stuffs. Some cows do not give sufficient milk or butter fat to pay for the feed which they consume. Other cows are highly profitable. Both kinds of cows may be found in the same herd.

The composition and quantity of milk depend on the breed, the individual animal, the period of lactation, frequency of milking, and other conditions. Milk cows may be divided into two groups; the members of one group give relatively large quantities of milk with a moderate fat content, and the members of the other group give less milk but it contains a higher percentage of butter fat. The amount and composition of milk given by the same cow varies to some extent from day to day. The amount of milk given decreases with the time that the animal has been giving milk. With some cows, the decrease is regular and gradual; while others give the same quantity for a long time and then fall off rapidly.

The milk-secreting organs are closely related to the nervous system. Thus rough treatment, insufficient bedding, exposure to cold temperatures, and other unfavorable conditions, will decrease both the quantity and the quality of the milk.

The quantity of milk and its composition depend on the individual capacity of the animal, but they also depend on the quantity and quality of the food fed. It is not possible to push the production beyond the limits conditioned by the nature of the animal, but a deficiency of food will decrease the quantity of milk, shorten the period of lactation, and may permanently injure the productiveness of the animal. When an animal is fed on a sufficient ration, and is changed to a ration containing insufficient food, there will be a reduction in the quantity and the quality of the milk.

Feeding standards for milk cows are based on the quantity of milk given and the maintenance requirements of the animal. The usual plan is to feed a certain amount of roughage, and then to feed a mixture of concentrates in proportion to the quantity of milk given.

FEEDING STANDARDS AND FEEDING

Table No. 8 gives the standards which seem advisable for use for various feeding purposes, based on 1,000 pounds of live weight. Standards are calculated: first, upon the basis of exact experiments to ascertain the needs of the animal; secondly, on feeding experiments with various rations, carried on in large number and in various parts of the world in which the effects of the rations were determined; and, thirdly, on the experience of practical feeders of large numbers of rations. In preparing the feeding standards here suggested, those of Armsby (1), and Henry and Morrison (28) have been consulted, as well as the work of Joseph (29), Kellner (30), Kriss (31), Savage (32), and Stiles and Morrison (33).

The standards represent the rations which should, as a rule, give the best results. The ration may need to be changed or modified according to the individuality of the animal. The standards must not be regarded as fixed rules but are merely intended to enable a feeder to start with a well-balanced average ration. He should then modify or change the ration to suit the requirement of his animals. This is particularly necessary in view of the fact that the feeding stuff used may differ materially from the average given in the table of analyses, and used in the feeding standards. As already shown, there is a considerable variation in the composition and feeding values of different feeding stuffs of the same kind, and the feeder must take this fact most carefully into consideration.

The suitability of the feed to the animal to which it is given must also be considered. Some animals are only able to utilize small quantities of certain feeding stuffs, but large quantities do not agree with them. The palatability of the feed is also to be considered.

Every change in the food, whether it is a new food or a change in quantity, should be gradual, covering a period of four to seven days.

The feeding standards and the tables of analyses may also be used to great advantage in studying the rations which are being fed to animals, and to ascertain whether they cannot be improved in feeding value, or lowered in cost. This is a very important and significant use of the table. As has been pointed out in other parts of this Bulletin, it is very often of advantage to feed higher quantities of protein than are called for in the standards on account of the comparatively low cost of cottonseed meal at various times in this State. That is to say, the protein could be fed for its productive value, and not for its value as material for forming flesh only.

Table 8. Tentative standards for feeding per day per 1000 lbs. live weight.

Animal	Per day per 1000 lbs. live weight		
	Dry matter Pounds	Digestible crude protein Pounds	Productive value therms
Growing dairy cattle			
Weight 100-200 pounds	22.0—24.0	2.8 —3.1	15.6 —17.5
Weight 200-300 pounds	23.0—25.0	2.5 —2.8	15.1 —17.0
Weight 300-400 pounds	24.0—26.0	2.2 —2.5	14.2 —16.0
Weight 400-500 pounds	22.0—25.0	1.9 —2.2	13.3 —15.0
Weight 500-600 pounds	21.5—24.5	1.7 —1.9	12.6 —14.5
Weight 600-700 pounds	21.0—24.0	1.6 —1.8	12.0 —13.8
Weight 700-800 pounds	20.5—23.5	1.5 —1.7	11.0 —13.0
Weight 800-900 pounds	20.0—23.0	1.4 —1.6	10.4 —12.3
Weight 900-1,000 pounds	20.0—23.0	1.2 —1.9	9.7 —11.4
Growing steers with some fattening			
Weight 100-200 pounds	22.0—24.0	2.8 —3.1	15.8 —17.7
Weight 200-300 pounds	23.0—25.0	2.5 —2.8	15.6 —17.5
Weight 300-400 pounds	24.0—26.0	2.2 —2.5	14.5 —16.4
Weight 400-500 pounds	24.0—26.0	2.0 —2.2	14.0 —15.9
Weight 500-600 pounds	23.0—25.0	1.9 —2.1	13.7 —15.5
Weight 600-700 pounds	22.0—24.0	1.8 —2.0	13.3 —15.2
Weight 700-800 pounds	21.0—23.0	1.7 —1.9	13.0 —14.9
Weight 800-900 pounds	20.5—22.5	1.6 —1.8	12.6 —14.5
Weight 900-1,000 pounds	20.0—22.0	1.5 —1.7	12.3 —14.1
Weight 1,000-1,100 pounds	19.5—21.5	1.4 —1.6	11.8 —13.7
Weight 1,100-1,200 pounds	19.0—21.0	1.3 —1.5	11.4 —13.3
Fattening 2-year-old steers on full feed			
First 40-60 days	22.0—28.0	1.7 —2.0	14.3 —16.2
Second 40-60 days	20.0—30.0	1.6 —1.9	13.2 —15.7
Third 40-60 days	18.0—28.0	1.5 —1.8	13.0 —15.3
Ox at rest in stall	13.0—21.0	0.5 —0.7	6.8 — 7.8
Wintering beef cows and calves	14.0—25.0	0.7 —0.8	8.0 —10.0
Horses			
Idle	13.0—19.0	0.8 —1.0	6.5 — 8.4
At light work	15.0—21.0	1.0 —1.2	8.4 —10.5
At medium work	16.0—22.0	1.2 —1.5	10.0 —13.0
At heavy work	18.0—24.0	1.5 —2.0	13.0 —16.0
Brood mares suckling foals, but not at work	15.0—22.0	1.2 —1.4	8.4 —11.2
Growing colts, over 6 months	18.0—22.0	1.6 —1.8	10.0 —12.0
Fattening lambs			
Weight 50-70 pounds	27.0—30.0	2.6 —3.0	18.0 —20.5
Weight 70-90 pounds	28.0—31.0	2.4 —2.7	18.0 —21.4
Weight 90-110 pounds	27.0—31.0	2.2 —2.4	18.0 —21.4
Fattening sheep	24.0—32.0	1.6 —2.0	15.0 —16.0
Dairy cows			
For maintenance of 1000-lb. cow		.60	6.0
To allowance for maintenance add:			
For each pound of 3.0% milk		.045— .055	.25
For each pound of 4.0% milk		.053— .065	.30
For each pound of 5.0% milk		.060— .070	.35
For each pound of 6.0% milk		.065— .080	.40
For each pound of 7.0% milk		.070— .085	.45
Sheep maintaining, mature			
Coarse wool	18.0—23.0	1.0 —1.3	9.5 —12.0
Fine wool	20.0—26.0	1.1 —1.4	10.5 —13.0
Breeding ewes, with lambs	23.0—27.0	2.5 —2.8	16.7 —18.6

EXACT CALCULATION OF A RATION

Before beginning to calculate a ration, it is necessary to decide on the ration desired, the feeds available, and their probable composition. In calculating the ration we must consider:

1. The desired productive energy.
2. The desired bulk.
3. The desired protein content.

All these vary somewhat, especially the bulk and the protein.

We will term the method of calculation given below, the method of substitution. It is best given by an example. Suppose we desire a ration with a bulk of about 24 pounds 1.6 pounds of digestible protein, and productive value of 13.0 therms, and wish to use corn chop, 43 per cent protein cottonseed meal, and cottonseed hulls, having the average composition given in Table 11. As these feeds all contain about ten per cent water, for which allowance has been made in considering the total bulk to be fed, it is not necessary to calculate to dry matter.

First, let us assume that the 24 pounds fed is entirely cottonseed hulls. This quantity of cottonseed hulls has a productive value of 24 X .179 = 4.30 therms. The value desired is 13.0 therms, leaving a deficiency of 8.7 therms. If now we replace cottonseed hulls having a productive value of .179 a pound by corn chop having a productive value of .858 therms per pound, for every pound of cottonseed hulls replaced, we gain .858 — .179 = .679 therms of productive energy. Dividing 8.7 by .679 we have 12.8 pounds of corn chops, which should replace an equal amount of cottonseed hulls leaving 24.0 — 12.8 = 11.2 pounds of cottonseed hulls.

11.2 pounds of cottonseed hulls and 12.8 pounds of corn chops contain $11.2 \times .004 + 12.8 \times .064 = 0.86$ pounds protein while 1.6 pounds is desired, a deficiency of .74 pound protein. Since cottonseed meal has nearly the same productive value as corn chops, it can replace corn chop without materially altering the productive value of the ration. If one pound of average 43 per cent protein cottonseed meal containing 0.359 pounds of digestible protein replaces one pound of corn chops containing 0.064 pound digestible protein, the digestible protein increases 0.359 — 0.064 = 0.295 pounds; hence to increase the ration .74 pound, we require .74 divided by .295 = 2.5 pounds cottonseed meal in place of an equal quantity of corn chops. The ration would then consist of 11.2 pounds of cottonseed hulls, 10.3 pounds of corn chop, and 2.5 pounds of cottonseed meal. The substitution of 1 pound of cottonseed meal for 1 pound of corn chops decreases the productive value .858 — .749 = .109 or 0.25 therm for the 2.5 pounds substituted; and this can be adjusted by adding .30 pound of corn chops, making a total of 10.6 pounds of corn chops in the ration. This finally gives the ration desired, consisting of 10.3 pounds corn chops, 2.5 pounds cottonseed meal, and 10.9 pounds cottonseed hulls.

10.8
2.5
10.9
24.0

The method of calculation used above may be stated as follows:

1. Assume that all the bulk desired is composed of the roughage to be used and calculate its productive energy.

2. Calculate the quantity of concentrate which would give the desired productive energy if it replaced a portion of the roughage.

3. Calculate the protein in the mixture having the composition ascertained above, and then calculate the quantity of a concentrate rich in protein which must replace a portion of the other concentrate in order to give the desired quantity of protein. The calculation is easier if the two concentrates have nearly the same productive energy.

4. Adjust the ration by increasing or decreasing the quantity of one of the concentrates slightly, so that the change in the productive energy caused by the change in the amount of the second concentrate may be allowed for.

With three feeds, only one combination is possible to secure a given mixture, but if more than three feeds are used, a large number of combinations is possible. A fourth feed may be substituted for the feed which it most closely resembles in any proportion, and the excess or deficiency in digestible protein or productive energy may be adjusted by changes in the amounts of the other feeds. Other feeds may be introduced in a similar way.

The calculation can also be made by the aid of algebraic equations.

IMPROVING A RATION

Suppose a horse weighing 1,000 pounds is at hard work, plowing for example, and is receiving 4 pounds corn, 4 pounds wheat bran, and 14 pounds Bermuda hay. How does this ration compare with the standard and how can it be improved? First, calculate the digestible protein and productive energy of the ration, using the average values of Table 11. (See Table 9.)

Table 9. Starting point for calculation of horse ration.

Feed	Feed pounds	Per cent digestible protein in feed	Pounds digestible protein in ration	Therms productive energy in 100 pounds feed	Therms in ration
Corn chops	4	6.4	.26	85.8	3.43
Wheat bran	4	12.9	.52	56.8	2.27
Bermuda hay	14	3.0	.42	31.3	4.38
Total	22		1.20		10.08
Horse at heavy work, standard (18-24 lbs. dry matter)	----	-----	1.5—2.0	-----	13—16
Desired ration	22	-----	1.70	-----	14.00
Deficiency	----	-----	.50	-----	3.92

the productive energy .858—.313=.545; so to gain the 3.92 pounds desired would take 3.92 ÷ .545 = 7.2 pounds of corn chops. Each pound

The ration is lower than is desired in protein and in productive energy. Productive energy may be increased by substituting corn for part of the Bermuda hay. One pound of corn substituted for hay increases of corn chops substituted would increase the protein in the ration .064 — .030 = .034 pound, or 7.2 pounds would increase it .24 pound. This would increase the total protein to 1.44, but would still leave a deficiency of 0.26 pound protein. If we replace corn by wheat bran to supply this protein, we require .26 ÷ (.129 — .064) = 4 pounds wheat bran. This, however, would cause a deficiency in productive energy of 4×.858—.58=1.11 therms. This deficiency could be made up by replacing Bermuda hay by corn, 1.11÷.545=2.0.

The calculated ration would then be as follows:

		Pounds
Corn	4 + 7.2 — 6 +2.1 =	7.3
Wheat bran	4 +6 =	10.0
Bermuda hay	14 —7.2—2.1 =	4.7
Total		22.0

REDUCING THE COST OF A RATION

The commercial prices of feeding stuffs are often not in proportion to their feeding values, and rations may often be modified so as to reduce the cost of the ration. There are four things to be considered in reducing the cost of a ration: (1) the suitability of the feed to the animal; (2) the cost of the productive value; (3) the cost of the digestible protein per pound; (4) the cost of the bulk or volume of the feed.

The three last factors can be calculated from the known selling price, the protein content, and productive energy, as already shown. The bulk of the feed may be measured by the total amount of dry matter. It often happens that some hays cost more per unit of feeding value than concentrated feeds. In such cases, the other cheaper bulky feeds should be used, and the difference in nutritive value compensated for by increasing the concentrates.

Suppose a feeder who is using 6 pounds of wheat bran at a cost of $16.00 a ton, can secure corn at $23.00 and cottonseed meal at $24.00. Would it pay to substitute? Using average values of Table 11, six pounds of wheat bran contains 0.77 pound of protein and 3.48 pounds of productive energy. The weight of corn containing 3.48 pounds of productive energy would be 3.41 ÷ .858 = 4.0 pounds of corn, which would contain 4 X .064 = .256 pound of protein, or a deficiency of 0.51 pound of protein. Replacing sufficient corn by cottonseed meal to balance the protein, 0.51 ÷ (.359 — .064) = 1.7 pounds. That is, 1.7 pounds of cottonseed meal and 2.6 pounds of corn are equivalent to 6 pounds of wheat bran. The cost would be 6 X .8 = 4.8 cents for wheat bran; and for the mixture, 1.7 × 1.2 = 1.93 for the cottonseed meal, and for the corn 2.6 × 1.1 = 2.86 cents, a total of 4.79 cents for the mixture or practically the same thing. It does not always follow that a change like this should be made, as the use of the wheat bran may be preferable for other reasons.

The preceding illustration shows the method which may be followed in reducing the cost of a ration. In substituting for protein, a suitable feed providing the protein at the lowest cost per unit should be used. In substituting for productive energy, a suitable feed providing the most productive energy for the money should be used, and the same remark applies to substituting for bulk.

The calculations could also be made by the method of algebra.

DISCUSSION OF FEEDING STUFFS

The average composition of Texas feeding stuffs is given in Table No. 11. The feeding values of the various feeding stuffs are also given in Table No. 11. There is a considerable variation in the composition of feeds, and it is necessary to recognize this fact in applying the tables to feeding conditions.

Definitions of feeding stuffs have been adopted by the Association of American Feed Control Officials. They are published in Bulletins of the Division of Feed Control Service of this Experiment Station.

Moisture in Corn Chops

It has been pointed out in Bulletin No. 152 of this Station that corn chops may heat under Texas conditions and the consumption of such heated corn or corn chop is dangerous to horses or mules. If corn chop contains over 14 per cent moisture, it is almost certain to spoil in Texas during the warm months. All grades of corn lower than No. 1 may contain over 14 per cent water. Lower grades should be dried, or so stored that they will dry out before being manufactured into corn chops or exposed to warm temperatures. Corn chops containing over 10 per cent of moisture should be well ventilated, or handled, if in bulk, so that it can dry out, especially during warm periods; otherwise, it is likely to heat.

U. S. Standard Grades for Hay, Grain, etc.

Descriptions of the U. S. Standards for grain, hay, and straw may be secured from the Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C.

Observations on Composition of Feeds

Fodder and stover. The term "fodder" refers to the entire corn or grain sorghum with the grain. The term "stover" refers to the plant from which the heads or grain have been removed.

Alfalfa hay. The feeding value depends to a considerable extent upon the percentage of leaves present. The leafy hay contains more digestible protein and has a higher productive value than the stemmy hay. The feeding value is not necessarily closely related to the grade.

Bur clover. This series of analyses shows the relation of stage of growth to feeding value. The young bur clover has a high feeding value, which decreases as the clover becomes older.

Table 10. Some production coefficients and coefficients of digestibility for ruminants.

	No. averaged	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Digestible protein
Alfalfa hay, below 30% crude fiber	40	.755	.812	—.152	.776	74.3
Alfalfa hay, 30 to 33% crude fiber	16	.722	.633	—.136	.756	71.1
Alfalfa hay, over 33% crude fiber	23	.695	.574	—.122	.732	68.4
Alfalfa hay, leafy, 21% crude fiber	1	.814	.650	—.025	.852	80.2
Alfalfa meal, 24% crude fiber	----	.648	.531	.053	.757	63.8
Alfalfa meal, 26 to 30% crude fiber	----	.761	.833	0	.778	74.9
Alfalfa meal, 30 to 33% crude fiber	----	.720	.618	.017	.755	70.8
Alfalfa ground, over 33% crude fiber	----	.704	.700	0	.737	69.3
Alfalfa silage	1	.555	.831	—.225	.460	54.6
Apple pomace, dried	3	0	.741	.132	.812	0
Apple pomace, fresh	5	.083	.848	.291	.858	8.2
Barley, grain (chops)	5	.756	1.692	.010	.915	80.0
Barley fodder, seeds forming, green	1	.695	1.000	—.027	.793	68.7
Barley hay, kernels not formed	1	.662	.827	.134	.678	65.2
Beans or peas (seed) average	10	.880	1.611	.280	.973	85.7
Beans, pinto	1	.885	1.472	.058	1.024	87.2
Bear grass (corrected)	2	.183	0	.120	.460	18.0
Beet pulp, dried	3	.602	0	.340	1.070	49.4
Bermuda hay	4	.520	.922	—.046	.559	51.2
Blue grass hay (Poa compresso) in blossom	1	.438	.754	.136	.669	43.1
Brewers' grains, dried	2	.690	1.712	.180	.511	80.8
Bromus inermis, hay	4	.560	.753	.022	.700	55.1
Broom corn, seed	2	.438	1.963	0	.709	43.1
Buffalo grass hay (Bulbilis dactyloides)	2	.547	.999	.042	.641	53.8
Cactus or prickly pear	2	.415	1.366	—.050	.836	40.9
Clover hay, crimson	4	.698	.886	—.117	.693	68.7
Clover hay, red	15	.605	1.032	—.062	.714	59.5
Clover hay, sweet	1	.767	.631	—.257	.772	75.5
Cocoanut oil meal	3	.888	2.584	.200	.960	87.4
Corn bran (commercial)	7	.433	1.409	.130	.705	53.3
Corn cobs, finely ground	5	.078	.503	—.027	.260	7.7
Corn meal or chops	15	.651	2.286	0	.988	64.1
Corn, whole grain (estimated)	----	.651	2.286	0	.938	61.1
Corn, cob and shuck, ground	----	.606	2.188	0	.909	59.6
Corn and cob, ground	----	.621	2.220	—.020	.918	61.1
Corn fodder, cured, dough to mature	----	.394	1.113	.077	.566	51.7
Corn gluten feed	18	.817	1.557	.250	.928	84.6
Corn gluten meal	8	.845	1.686	—.100	.887	87.5
Corn silage, less than 20% crude fiber, dry basis	1	.493	1.753	—.261	.810	48.5
Corn silage, 20 to 25% crude fiber	12	.569	1.660	.102	.800	56.0
Corn silage, 25 to 30% crude fiber	16	.498	1.591	.116	.749	49.2
Corn silage, over 30% crude fiber	10	.498	1.520	.145	.711	49.1
Corn shucks	2	.213	.726	0	.363	21.0

Table 10. Some production coefficients and coefficients of digestibility for ruminants.—(Continued.)

	No. averaged	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Digestible protein
Corn stover, pulled, chiefly blades	5	.297	1.021	.101	.499	29.2
Corn stover, entire plant except ears	9	.308	.956	.058	.472	40.5
Cotton boll refuse	1	.101	1.132	—.084	.496	9.9
Cotton burs	1	.284	1.342	—.364	.735	27.9
Cottonseed, raw	2	.748	2.371	.068	.630	73.6
Cottonseed meal, 6.0 to 8.0% crude fiber	---	.865	2.506	0	.725	85.1
Cottonseed meal, 8.01 to 10% crude fiber	---	.860	2.503	0	.705	84.6
Cottonseed meal, 10.01 to 12% crude fiber	---	.858	2.492	0	.690	84.4
Cottonseed meal, below 12% crude fiber	13	.843	2.496	.066	.726	83.0
Cottonseed meal and hulls, 12.01 to 14% crude fiber	---	.854	2.478	0	.631	84.1
Cottonseed meal, 14.01 to 16% crude fiber	---	.849	2.450	—.004	.571	83.6
Cottonseed cake, 6.0 to 8.0% crude fiber	---	.822	2.375	0	.689	85.1
Cottonseed cake, 8.01 to 10% crude fiber	---	.817	2.378	0	.670	84.6
Cottonseed cake, 10.01 to 12% crude fiber	---	.815	2.367	0	.656	84.4
Cottonseed cake and hulls, 12.01 to 14% crude fiber	---	.811	2.354	0	.599	83.0
Cottonseed cake, 14.01 to 16% crude fiber	---	.807	2.328	—.004	.542	83.6
Cottonseed meal and hulls, 18.6% crude fiber	1	.833	2.534	.074	.868	83.3
Cottonseed meal and hulls, 24 to 29% protein, 21% crude fiber	3	.764	2.483	—.207	.703	75.2
Cottonseed, whole-pressed	3	.814	2.512	—.131	.700	80.1
Cottonseed meal and hulls, 1½:1, 21% protein, 29% crude fiber	1	.661	2.207	—.106	.604	65.1
Cottonseed hulls and meal 5:1 to 7:1, 8.4-8.8% protein	2	.408	2.133	—.269	.564	40.2
Cottonseed hulls	15	.088	1.608	—.080	.564	8.7
Cottonseed hulls, delinted	1	0	1.553	.114	.675	8.7
Cowpeas, meal	1	.833	1.680	.355	.997	82.0
Cowpeas, hay	2	.696	.820	—.116	.728	68.6
Cowpea silage	2	.346	1.006	—.117	.579	34.1
Darso grain, cracked	1	.737	1.982	.510	.987	72.5
Distillers grain, 24 to 39% protein	9	.668	1.911	—.200	.743	73.1
Distillers grains, 16% protein	2	.469	1.682	—.500	.450	51.3
Feterita grain	3	.778	1.678	0	.980	76.5
Feterita heads, ground	---	.768	1.971	—.064	.972	75.6
Feterita stover	1	.509	1.197	.100	.653	50.1
Flax plant by-product	4	.204	.888	—.472	.361	20.1
Hay, less than 8% protein, general average	---	.510	.820	.036	.640	50.4
Hay, 8 to 11% protein, general average	---	.600	1.020	.070	.680	59.0
Hay, legume, general average	---	.718	1.034	—.039	.750	70.7
Hominy feed or meal	5	.693	2.369	—.140	.973	68.2
Johnson grass hay (Andropogan halepensis)	4	.446	.909	.092	.608	43.9
Kafir, ground or chopped	---	.781	1.852	0	1.008	76.9
Kafir heads, chopped	---	.702	1.842	.040	.938	69.1
Kafir fodder (with heads)	2	.529	1.237	.015	.733	52.1
Kafir stalks, no heads	---	.405	1.229	.036	.493	
Kafir head stems, "pummies"	1	.205	1.080	—.262	.470	20.2

Table 10. Some production coefficients and coefficients of digestibility for ruminants.—(Continued.)

	No. averaged	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Digestible protein
Kafir silage	1	.289	1.026	0	.644	28.5
Linseed meal, old process	4	.852	2.382	.019	.880	83.9
Linseed meal, new process	6	.867	2.018	—.206	.953	85.3
Malt sprouts	2	.650	1.403	.648	.733	76.2
Mesquite beans	3	.919	1.945	.013	.871	92.7
Mesquite grass hay	1	.043	1.381	—.150	.390	4.2
Millet grain, ground	3	.694	1.984	0	.970	68.3
Millet grain, whole	3	.596	1.809	—.387	.904	58.7
Millet hay, choetochloa italica	1	.316	1.137	.060	.594	31.1
Millet hay, barnyard	2	.617	.967	.080	.580	60.8
Milo fodder, cured, stalk and heads	1	.387	1.612	.154	.837	38.1
Milo stover, cured, stalks without heads	1	0	1.155	.088	.527	0
Milo fodder, green	1	.165	1.286	—.072	.693	16.2
Milo head chop	2	.768	1.971	—.064	.972	75.6
Milo ground	—	.739	1.929	.047	1.033	72.7
Milo, whole grain	2	.781	2.028	.070	.965	76.9
Molasses	18	.141	0	0	.961	13.8
Oats, 10 to 12% crude fiber	8	.802	1.965	.128	.877	79.0
Oats, unground, 16% fiber	1	.721	2.100	.287	.878	71.0
Oat hulls	3	.190	.569	0	.427	18.7
Oat hull clippings	3	.406	1.603	0	.427	39.9
Oat middlings, fine	1	.817	2.411	.207	1.020	80.4
Oat meal mill by-product	8	.613	1.925	.047	.455	60.3
Oat hay	7	.553	1.286	—.039	.614	54.4
Oat straw	5	.122	.590	.019	.425	12.0
Orchard grass hay	2	.605	1.084	.030	.599	59.5
Para grass hay	1	.101	.918	—.052	.502	9.9
Pea meal (Canada)	1	.845	1.239	—.061	1.002	83.2
Pea straw (poor quality hay with peas shelled out)	1	.795	1.011	—.074	.849	78.2
Peanuts, whole	2	.821	2.413	—.249	.137	80.8
Peanut hulls or shells	6	.525	1.717	—.442	.615	51.7
Peanut meal	2	.902	2.461	.080	.897	88.8
Peanut skins	1	.265	2.375	—.318	.169	24.8
Peanut hay with many nuts	3	.770	2.092	—.104	.731	75.8
Peanut hay, few nuts	5	.657	1.253	—.068	.812	64.6
Rhodes grass hay	2	.459	.999	.121	.655	45.2
Rice bran, 7.0 to 9.0% crude fiber	—	.728	2.161	.046	.872	71.7
Rice bran, 9.01 to 11.0% crude fiber	—	.717	2.154	—.061	.842	70.6
Rice bran, below 12% crude fiber	6	.699	2.149	—.040	.789	68.8
Rice bran, 13.01 to 15% crude fiber	—	.690	2.130	—.121	.777	67.9
Rice bran and hulls, 15.01 to 18% crude fiber	—	.670	2.162	—.158	.733	65.9
Rice bran and hulls, 19.01 to 20% crude fiber	—	.647	2.092	—.178	.687	63.7
Rice rough (grain with hulls)	3	.768	1.731	—.205	.971	75.6

Table 10. Some production coefficients and coefficients of digestibility for ruminants.—(Continued.)

	No. averaged	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Digestible protein
Rice hay	1	.384	1.143	—.068	.510	37.9
Rice hulls	3	.029	.294	—.232	.183	2.9
Rice polish	5	.720	2.243	—.038	.993	70.9
Rice straw	2	.220	.437	.015	.494	21.7
Rye meal	1	.857	1.458	0	.984	84.4
Sesame cake	1	.924	1.581	0	.316	90.9
Shallu forage (corrected)	1	.300	1.000	0	.400	29.5
Sorghum bagasse or mill refuse (corrected)	2	.070	.473	0	.400	6.9
Sorghum fodder, cured	6	.320	1.184	.031	.633	31.5
Sorghum fodder, green	5	.355	1.500	0	.748	34.9
Sorghum silage	2	.163	1.201	0	.704	16.0
Sorghum seed	1	.575	1.283	.500	.936	56.5
Soy bean hay	3	.729	.769	0	.752	71.7
Soy bean oil meal	5	.847	2.126	.117	.962	83.4
Soy bean meal and whole soy beans	6	.917	2.367	0	.794	90.3
Soy bean silage	3	.650	1.179	—.028	.677	64.0
Speltz or emmer, grain	4	.620	1.521	.132	.725	81.4
Sudan grass, green	2	.736	1.553	.197	.734	72.4
Sudan hay	11	.527	.932	.079	.583	51.8
Sudan straw	1	.466	.704	.026	.511	45.9
Sunflower, common	1	.706	1.290	0	.655	69.5
Sunflower silage	5	.866	2.830	—.075	1.211	85.2
Tobosa grass hay	2	.202	.760	—.140	.509	19.9
Timothy, green	1	.489	1.085	0	.704	48.1
Timothy hay	38	.449	1.053	—.067	.646	44.2
Velvet bean feed (bean and pods)	5	.760	1.860	.162	.949	74.8
Velvet bean hay	1	.699	1.606	.218	.811	68.8
Velvet bean vines, green	1	.745	1.659	.021	.883	73.3
Vetch fodder, vicia sativa, green	1	.725	1.196	—.244	.815	71.4
Vetch hay, all samples	4	.690	1.275	—.017	.755	68.9
Vetch silage, unsteamed	1	.573	1.579	.057	.716	56.4
Wheat, whole	5	.732	1.541	.038	.949	81.0
Wheat, ground	5	.774	1.628	.040	1.002	81.9
Wheat flour middlings or gray shorts	7	.796	1.871	.356	.899	84.2
Wheat mixed feed	2	.624	.930	.388	.550	76.9
Wheat bran	12	.683	1.346	.302	.678	78.4
Wheat brown shorts	3	.709	1.656	.234	.753	82.1
Wheat flour, low grade	1	.804	1.556	0	1.000	79.1
Wheat standard middlings	1	.591	1.556	.246	.606	75.6

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Acorns, fresh, post-oak group	3.0	3.4	6.5	35.8	50.0	1.3	7	0	23.7
Acorns, fresh, red-oak group	3.2	10.7	9.9	25.0	50.0	1.2	7	0	32.1
Acorns, dried, post-oak group	5.6	6.5	12.3	67.2	6.0	2.4	7	0	44.8
Acorns, dried, red-oak group	6.1	20.1	18.7	47.1	5.7	2.3	7	0	60.4
Acorn hulls, fresh	2.8	1.1	21.7	36.9	35.9	1.6	4	.2	21.1
Acorn hulls, dried	3.8	1.4	43.8	41.8	6.8	2.4	10	.3	22.1
Acorn kernels, fresh, live-oak group	4.3	4.0	2.2	47.8	40.0	1.7	7	0	33.6
Acorn kernels, fresh, red-oak group	5.2	20.3	8.4	37.9	26.5	1.7	7	0	60.6
Acorn kernels, dried, live-oak group	6.1	7.9	3.2	74.6	5.8	2.4	6	0	56.8
Acorn kernels, dried, red-oak group	6.9	27.0	9.5	49.0	5.3	2.3	9	0	80.7
Agrito foliage, dried	10.3	2.4	30.6	47.6	6.1	3.0	1	2.2	26.7
Alfalfa, chopped, (minimum)	13.0	1.5	33.0	35.0	----	----	----	8.9	32.3
Alfalfa hay, average	14.8	2.0	29.1	37.4	8.3	8.4	92	11.0	37.4
Alfalfa hay, U. S. Grade No. 1	13.0	2.4	26.7	43.6	6.6	7.7	1	9.7	41.5
Alfalfa hay, U. S. Grade No. 2	17.3	1.8	22.2	39.9	6.1	12.7	1	12.9	42.1
Alfalfa hay, U. S. Grade No. 3	17.5	1.3	27.3	37.1	6.3	10.5	2	13.0	38.9
Alfalfa hay, leafy	18.5	1.5	21.8	39.6	6.6	12.0	3	14.8	49.2
Alfalfa leaf meal	21.5	2.6	15.8	40.5	7.7	11.9	28	16.1	52.3
Alfalfa leaf meal (minimum)	20.0	2.5	18.0	40.0	----	----	----	15.0	50.9
Alfalfa meal	14.6	1.8	29.9	36.8	8.6	8.3	265	10.9	41.2
Alfalfa meal (minimum)	13.0	1.5	33.0	35.0	----	----	----	9.2	37.3
Alfalfa stem meal	11.5	1.3	36.1	36.5	8.0	6.6	23	8.0	35.9
Alfalfa stem meal (minimum)	9.0	.8	40.0	30.0	----	----	----	6.2	29.0
Angleton grass, dried	3.0	1.7	36.6	44.1	6.6	8.0	2	1.6	31.8
Aristida grass, dried	7.5	1.4	32.5	41.9	6.1	10.6	3	3.8	33.0
Barley, 8 inches high, cut green	3.6	.6	2.4	3.1	88.3	2.0	1	2.4	5.3
Barley, 8 inches high, cut green, dried	28.9	5.1	18.6	24.7	7.1	15.6	1	21.5	42.3
Barley chops (grain)	12.0	2.1	6.3	67.5	9.3	2.8	336	9.6	74.4
Barley chops, whole (minimum)	11.0	1.5	6.0	65.0	----	----	----	8.8	70.4
Barley feed meal	12.3	2.1	6.2	66.9	9.9	2.6	3	9.8	74.1
Barley, ground hull-less	12.5	2.6	3.0	71.8	8.4	1.7	2	10.0	79.6
Barley, hulled (minimum)	10.0	2.5	2.5	72.0	----	----	----	8.0	83.5
Barley malt	12.8	2.1	5.2	71.3	6.3	2.3	6	10.2	78.5
Barley middlings	11.8	1.8	5.7	64.5	13.5	2.7	2	9.4	76.4
Bean meal	23.4	1.8	3.5	56.7	9.9	4.7	2	20.4	81.6
Bean, Bayo gordo	22.6	1.8	4.7	56.7	9.8	4.4	2	19.7	81.0
Beans, California pink (seed)	24.4	1.3	4.0	57.4	9.3	3.6	1	21.3	82.5
Bean, (seed) Dolichos biflora	22.8	.3	5.6	61.5	6.1	3.7	1	19.9	83.9
Bean, (plant) Dolichos biflora	15.4	.2	28.4	39.7	5.9	10.4	1	10.6	36.5
Bean, Guafilla, seed	18.8	4.1	7.9	60.1	6.4	2.7	1	16.4	84.7

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Bean, Japanese	21.0	1.2	4.4	62.8	7.1	3.5	1	18.3	84.9
Bean, moth, seed	15.8	1.3	28.6	35.9	6.6	11.8	1	13.8	54.3
Bean, moth (seed and pod)	18.8	.3	11.9	55.7	8.3	5.0	1	14.1	69.6
Bean, pinto (seed)	22.9	1.3	4.1	58.1	9.3	4.3	4	20.0	81.9
Bear grass, Yucca Glauca, green	4.0	1.1	20.7	21.3	48.3	4.6	2	.7	19.3
Bear grass (dried)	7.1	2.0	38.3	38.4	6.0	8.2	4	1.3	34.9
Bear grass silage, fresh	2.1	1.6	12.5	15.7	64.7	3.4	1	.4	8.3
Bear grass silage, dried	5.6	4.2	34.0	42.6	4.5	9.1	1	1.0	22.6
Stock beets, dried	19.8	.5	7.5	57.7	5.7	8.8	1	9.8	63.5
Stock beets, fresh	2.7	.1	1.0	7.7	87.3	1.2	1	1.3	8.5
Beet pulp, dried	9.0	.6	19.3	59.0	8.5	3.6	42	4.5	75.1
Beet pulp, dried (minimum)	8.0	.5	22.0	52.0	......	......	......	4.0	67.9
Bermuda hay	5.9	1.5	26.7	50.3	7.8	7.8	12	3.0	31.3
Blood meal	79.4	1.2	1.5	2.8	9.6	5.5	7	66.7	69.9
Blood meal (minimum)	80.0	1.0	2.0	3.0	......	......	......	67.2	70.0
Bone meal, raw	25.5	2.2	1.2	4.2	5.2	61.7	20	21.2	30.1
Bone meal, raw (minimum)	23.0	7.0	5.0	0	......	......	......	19.1	37.2
Bone meal, special steamed	7.7	.6	2.7	4.9	3.3	80.8	3	6.4	11.7
Bone meal, special steamed (minimum)	5.0	0	3.0	4.0	......	......	......	4.2	7.3
Brewers' grains, dried	21.9	6.3	17.8	43.2	6.7	4.1	13	17.7	51.2
Brewers' grains, dried (minimum)	24.0	6.0	18.0	40.0	......	......	......	19.4	50.5
Broom corn (seed)	9.9	2.3	12.4	61.9	7.4	6.1	3	4.3	52.7
Browse (Condalia obtusifolia, chaparro Prieto)	14.0	2.4	21.0	50.4	7.2	5.0	3	9.6	46.0
Browse (Guaiacum Coulteri)	19.4	6.3	19.3	36.7	5.7	12.6	3	13.3	43.2
Buckwheat (minimum)	10.0	2.5	10.0	62.0	......	......	......	7.9	68.6
Buckwheat (seed)	11.0	2.3	12.9	62.2	9.9	1.7	2	8.7	69.5
Buffalo grass	7.2	1.5	24.2	46.2	8.1	12.8	10	3.9	36.1
Bull nettle seed	24.6	32.8	21.7	10.0	7.0	3.7	1	......	......
Bur clover, just in bloom (dried)	27.1	4.2	14.1	40.5	3.0	11.1	1	20.1	53.2
Bur clover, full bloom, part of seeds formed (dried)	24.0	3.2	17.0	38.2	7.4	10.2	1	17.8	47.8
Bur clover, most of suck formed (dried)	20.8	3.0	21.9	41.0	2.7	10.6	1	15.5	46.6
Bur clover, still in bloom (dried)	21.1	3.9	21.3	38.3	6.0	9.4	1	15.7	45.6
Bur clover, part of leaves dying, still blooms (dried)	16.4	2.5	25.6	40.6	6.0	8.9	1	12.2	42.0
Bur clover, all seeds formed, some leaves dry and dropping off (dried)	15.7	2.6	30.6	36.7	6.9	7.5	1	11.2	36.6
Bur clover, most of leaves and burrs have dropped off (dried)	11.0	1.8	38.3	33.4	7.1	8.4	1	7.5	28.5
Buttermilk, dried	34.4	5.0	.4	40.6	8.2	11.4	65	32.6	85.5

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Buttermilk, dried (minimum)	32.0	6.0	1.0	35.0	----	----	----	30.1	80.9
Buttermilk, semi-solid	10.9	2.0	0	11.1	72.8	3.2	5	10.3	26.6
Cactus, dried	3.5	1.1	9.8	51.3	16.7	17.6	7	1.4	45.4
Cactus, green	1.3	.4	4.7	17.6	68.3	7.7	7	.5	15.6
Cactus leaves, dried	3.5	1.5	12.3	49.3	5.8	27.6	1	2.3	44.5
Cactus fruit, dried	6.4	1.0	10.3	41.6	22.5	18.2	5	3.2	35.7
Cactus fruit, fresh	1.1	.1	.6	5.5	91.6	1.1	2	.6	5.0
Cactus silage, fresh	.5	.4	1.7	5.0	90.4	2.0	1	0	4.9
Cactus silage, dried	4.8	3.6	17.0	50.9	3.9	19.8	1	3.1	49.3
Cane, Japanese (dry basis) leaves	4.8	2.1	34.7	44.4	5.5	8.5	2	2.9	40.4
Cane, Japanese (dry basis) roots	2.7	.6	28.5	37.0	5.5	25.7	2	----	----
Cane, Japanese (dry basis) stalks	2.6	1.0	26.7	61.5	4.8	3.4	2	----	----
Cane, Japanese, (dry basis) stalks and leaves	3.1	1.5	29.1	57.0	4.7	4.7	3	1.0	39.8
Cane leaves, Japanese (moist basis)	2.4	1.1	17.8	22.6	51.8	4.3	2	----	----
Cane stalks, Japanese (moist basis)	.6	.2	6.1	14.0	78.3	.8	2	----	----
Cane, Japanese, stalks & leaves (moist basis)	.8	.4	7.7	15.2	74.7	1.2	3	----	----
Careless weed (pig weed) dried	18.8	1.3	16.0	33.7	7.7	22.5	2	14.0	39.0
Careless weed (pig weed) green	3.4	.3	2.2	6.0	83.4	4.7	1	1.2	6.2
Careless weed silage	6.4	.7	11.0	10.1	64.6	7.2	1	3.1	13.0
Carpet grass (dried)	5.1	1.2	32.5	46.1	9.0	6.1	1	2.6	34.3
Chili pepper seed	17.0	25.0	30.4	18.4	5.9	3.3	1	13.6	87.3
Chinese tallow tree seed	9.1	42.6	34.7	5.7	6.0	1.9	1	7.4	102.4
Clover, sweet, hay (low grade)	9.3	1.1	43.2	33.4	8.7	4.3	1	7.0	22.5
Clover, sweet, hay, dried	17.9	2.4	20.2	42.4	9.2	7.9	1	13.5	42.8
Clover, sweet, straw	5.0	1.1	48.0	35.1	7.4	3.4	1	3.8	19.3
Cocoa bean shells	14.8	6.7	15.0	50.0	5.0	8.5	2	1.7	57.4
Cocoanut oil meal (minimum)	20.0	6.0	12.0	40.0	----	----	----	17.5	74.1
Cocoanut oil-cake	20.2	10.3	12.9	43.3	7.4	5.9	8	17.7	88.7
Cocoanut oil-meal	19.4	10.6	11.2	44.3	8.5	6.0	32	17.0	89.4
Cocoanut oil-meal, new process	21.4	2.4	13.3	47.4	8.9	6.6	12	18.7	73.4
Cod liver oil-cake	52.1	27.1	.9	10.1	7.0	2.8	1	43.2	119.0
Colorado grass	8.7	1.4	29.7	40.9	6.8	12.5	1	5.1	36.6
Corn, grain	10.4	4.4	2.3	72.5	9.1	1.3	105	6.4	84.8
Corn chops	10.0	4.0	2.4	71.0	11.2	1.4	2001	6.4	~~85.8~~
Corn chop (minimum)	9.0	3.5	3.0	70.0	----	----	----	5.8	83.0
Corn bran	10.3	6.9	9.0	61.8	9.7	2.3	240	5.5	58.9
Corn bran (minimum)	8.0	5.0	12.0	60.0	----	----	----	4.3	54.4
Corn cob	3.1	.5	33.0	54.0	7.3	2.1	12	.3	13.6
Corn cob (minimum)	2.0	.5	34.0	50.0	----	----	----	.2	12.5
Ear corn chops	9.2	3.7	7.1	67.1	11.3	1.6	44	5.5	74.7

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitro-gen-free extract	Water	Ash	No. aver-aged	Digesti-ble protein per cent	Produc-tive energy therms in 100 pounds
Corn chop, ear (minimum)	8.0	3.0	8.0	64.0	—	—	—	4.8	69.6
Ear corn chop with shucks	8.7	3.2	10.0	66.6	9.6	1.9	317	5.2	72.8
Corn chop, ear, with husk (minimum)	7.8	2.8	10.0	62.0	—	—	—	4.7	67.2
Corn feed meal	9.9	4.4	3.0	70.3	10.7	1.7	234	6.4	86.0
Corn feed meal (minimum)	8.0	3.0	3.0	67.0	—	—	—	5.1	78.3
Corn flour	8.6	4.0	.7	73.3	12.2	1.2	10	5.5	87.2
Corn fodder, green	1.8	.5	5.0	12.2	79.3	1.2	—	1.2	11.7
Corn fodder, field cured, entire plant	4.5	1.6	14.3	34.7	42.2	2.7	—	2.3	24.3
Corn germs	15.8	20.4	4.7	45.0	8.7	5.4	1	10.1	101.4
Corn germ oil-meal	18.3	7.4	7.9	55.5	7.3	3.6	11	14.0	85.7
Corn germ oil-meal (minimum)	18.0	7.0	9.0	50.0	—	—	—	13.8	80.2
Corn gluten feed	26.0	2.7	7.7	50.4	8.1	5.1	53	22.0	74.1
Corn gluten feed (minimum)	23.0	2.5	7.0	50.0	—	—	—	19.5	70.8
Corn gluten meal	41.8	1.9	3.8	42.5	7.4	2.6	3	36.6	75.8
Corn gluten meal (minimum)	40.0	1.0	4.0	40.0	—	—	—	35.0	70.6
Corn meal	10.1	3.5	1.7	73.1	10.4	1.2	27	6.5	86.8
Corn oil-cake meal	23.6	5.4	11.2	49.8	7.6	2.4	8	15.1	76.9
Corn shucks	3.2	.7	30.3	54.5	7.8	3.5	2	.7	21.0
Corn silage, dried	7.3	2.3	24.9	51.9	7.0	6.6	17	4.1	52.0
Corn silage, moist basis	2.3	.7	7.8	16.6	70.5	2.1	17	1.1	15.6
Corn stover, left after harvesting ears, high in water	3.8	1.1	19.7	31.5	40.5	3.4	—	1.5	18.2
Cotton bolls (with seed)	11.1	3.3	31.1	41.5	7.7	5.3	4	8.9	46.3
Cotton burs	8.0	2.6	34.3	38.7	8.7	7.7	22	2.1	23.1
Cotton burs (minimum)	8.0	2.0	30.0	44.0	—	—	—	2.1	26.6
Cotton leaves	15.6	7.4	9.9	42.8	6.8	17.5	12	11.6	49.5
Cotton lint	1.6	.4	83.9	7.0	5.7	1.4	6	0	0
Cotton pin trash, burs etc. (from gin)	8.0	2.4	24.0	25.3	6.4	33.9	4	.8	14.1
Cotton roots (dried)	8.0	1.4	44.8	30.9	6.2	8.7	2	0	0
Cotton stalks (dried)	6.7	.7	41.2	39.7	7.4	4.3	7	—	—
Cottonseed	20.9	17.9	23.8	26.9	7.0	3.5	142	15.4	76.6
Cottonseed, whole-pressed, 25% protein	27.1	7.1	24.2	30.3	7.0	4.3	329	22.1	61.2
Cottonseed, whole-pressed, 28% protein	28.5	6.1	23.3	32.1	5.7	4.3	31	22.8	61.0
Cottonseed, 25% protein, whole-pressed (minimum)	25.0	6.0	25.0	29.0	—	—	—	20.0	55.2
Cottonseed, 28% protein, whole-pressed (minimum)	28.0	6.0	23.0	29.0	—	—	—	22.4	57.9
Cottonseed cake, 43% protein	43.5	6.7	10.6	26.7	7.1	5.4	2242	36.1	73.5
Cottonseed cake, 43% protein (minimum)	43.0	6.0	12.0	23.0	—	—	—	34.5	64.3
Cottonseed cake, 45% protein	45.3	6.9	9.9	25.3	7.3	5.3	80	37.6	74.4

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Cottonseed cake, 45% protein (minimum)	45.0	6.0	10.0	22.0	......	......	......	37.4	69.6
Cottonseed meal, 45% protein	44.6	7.4	10.2	25.9	6.6	5.3	155	37.0	75.5
Cottonseed meal, 45% protein (minimum)	45.0	6.0	10.0	22.0	......	......	......	37.4	69.6
Cottonseed meal, 43% protein	43.2	7.5	10.8	26.2	6.8	5.5	5731	35.9	74.9
Cottonseed meal, 43% protein (minimum)	43.0	6.0	12.0	23.0	......	......	......	35.7	68.8
Cottonseed cake screenings	43.4	7.4	10.8	26.8	6.8	4.8	3	36.0	75.2
Cottonseed chop (minimum)	20.0	17.0	20.0	25.0	......	......	......	14.7	72.4
Cottonseed feed, 41.12% protein (minimum)	41.1	5.0	14.0	26.0	......	......	......	34.6	63.9
Cottonseed feed, 36% protein, ground	37.9	6.8	14.8	28.4	7.2	4.9	4	31.7	61.8
Cottonseed feed, 36% protein (minimum)	36.0	5.0	22.0	28.0	......	......	......	30.1	55.8
Cottonseed feed, 38.56% protein, ground	41.5	8.9	10.3	26.9	7.0	5.4	14	35.0	72.5
Cottonseed feed, 38.56% protein (minimum)	38.6	5.0	18.0	27.0	......	......	......	32.7	72.1
Cottonseed hulls, lintless	3.9	.6	38.9	45.4	8.6	2.6	20	0	36.0
Cottonseed hulls	4.1	.9	47.6	35.3	9.4	2.7	180	.4	17.9
Cottonseed hulls (minimum)	3.0	.5	50.0	30.0	......	......	......	.3	14.0
Cottonseed kernels	38.5	33.1	2.2	13.9	7.9	4.4	127	32.0	125.2
Cowpeas (seed)	23.6	1.5	4.1	55.8	11.6	3.4	......	20.6	80.5
Cowpea seed and pods, dried	21.7	1.3	10.8	53.8	7.7	4.7	3	16.2	71.7
Cowpea hay	13.1	2.9	30.6	33.9	9.6	9.9	6	9.0	32.6
Cowpea leaves, dried	24.3	8.5	11.2	35.1	5.9	15.0	2	16.7	48.1
Cowpea roots, dried	6.9	.7	48.5	29.0	5.9	9.0	2	......	......
Cowpea vine, dried	13.2	1.4	38.4	28.3	6.3	12.4	2	9.1	26.5
Crackers, ground	14.4	.4	.6	75.0	8.5	1.1	1	9.2	84.4
Dallis grass, (dried), young	12.7	2.8	26.9	39.8	5.7	12.1	1	7.4	39.4
Dallis grass (dried) old	8.7	1.8	32.1	40.3	6.7	10.4	1	5.1	36.7
Darso heads	9.0	2.4	8.2	68.0	9.8	2.6	1	6.6	79.9
Darso (seed) or chops	10.3	3.2	2.5	72.9	9.7	1.4	9	7.8	84.9
Egyptian wheat (see shallu)									
Elephant grass (dried)	4.3	1.3	40.3	44.8	4.5	4.8	2	2.2	33.4
Elevator grain dust	16.0	1.5	12.8	49.5	7.5	12.7	1	12.5	50.4
Emmer, black, seed	18.6	1.7	4.0	64.2	9.8	1.7	1	15.1	61.2
Emmer chops	14.6	2.0	6.8	64.3	9.1	3.2	11	11.9	59.6
Emmer chop (minimum)	11.0	1.5	10.0	63.0	......	......	......	9.0	56.1
Feterita fodder (heads included)	8.2	1.8	17.1	50.6	15.6	6.7	6	4.1	41.1
Feterita heads or head chops	10.6	2.7	7.4	65.9	10.2	3.2	16	8.1	77.4
Feterita head chop (minimum)	10.0	2.5	8.0	64.0	......	......	......	7.7	74.7
Feterita seed or chops	12.7	3.1	2.5	69.3	10.7	1.7	58	9.7	83.0
Feterita chop (minimum)	11.0	2.8	3.0	69.0	......	......	......	8.4	80.9
Feterita silage	3.7	.7	10.8	22.1	58.7	4.0	1	1.9	18.2
Fillera weed (dried)	15.0	1.7	13.7	47.5	7.8	14.3	7	11.2	47.5

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Fish meal	56.6	6.2	1.6	6.1	7.8	21.7	4	45.9	62.7
Fish meal (minimum)	50.0	5.0	1.0	1.0	—	—	—	37.6	51.1
Fish scraps	56.7	7.9	.8	4.6	7.4	22.6	1	46.0	67.2
Flax plant by-product	6.2	1.1	45.3	32.8	8.2	6.4	1	1.3	7.3
Flax plant by-product (minimum)	8.0	4.0	35.0	35.0	—	—	—	1.6	1.3
Flax seed (minimum)	22.0	32.0	7.0	23.0	—	—	—	19.5	111.9
Flax seed meal	28.4	30.4	18.4	11.8	7.0	4.0	1	23.8	107.3
Flour, low grade (minimum)	14.0	1.5	1.0	70.0	—	—	—	11.1	83.6
Flour, red dog (minimum)	15.0	2.5	4.0	65.0	—	—	—	11.9	81.0
Forney hay	4.0	2.3	24.4	52.8	8.0	8.5	1	2.0	38.6
Four o'clock plant (dried)	25.3	3.3	14.9	35.8	5.8	14.9	1	17.4	44.7
Fumitory grass	35.8	3.1	8.6	31.2	7.9	13.4	1	24.6	49.2
Garbage, household tankage	19.4	2.0	11.0	45.4	7.5	14.7	1	7.3	53.4
Graham flour	14.0	2.0	2.7	69.8	9.7	1.8	1	11.1	84.2
Goat weed (dried)	9.9	2.8	31.9	38.1	8.2	9.1	1	5.8	36.9
Grass, Andropogon Annulatus	4.4	1.9	39.3	37.0	8.6	8.8	1	2.2	29.0
Grass, Gramma (dried or hay)	4.6	1.3	26.7	43.7	6.7	17.0	5	2.3	32.4
Grass, Guinea	4.9	1.2	37.9	38.6	8.0	9.4	2	2.5	29.5
Grass, Hilaria belungeri	7.0	1.8	25.9	44.4	6.2	14.7	2	3.5	34.4
Grass, marsh, Jefferson county	4.4	1.6	30.4	44.1	12.9	6.6	1	2.2	32.9
Grass, Pennisetum purpureum	5.0	.8	39.7	42.2	5.1	7.2	1	2.5	31.7
Grass, "Poor Joe"	5.2	2.1	29.5	45.2	8.9	9.1	1	2.6	34.4
Grass, Pospalum notatum	6.8	1.2	29.5	43.3	8.1	11.1	1	3.4	33.2
Grass, Harris county, prairie (dried)									
July, 1924	4.9	1.8	30.6	48.1	6.3	8.3	8	2.5	35.9
August, 1924	4.3	1.8	30.1	48.4	6.6	8.8	12	2.2	35.7
September, 1924	4.1	2.1	31.0	48.4	6.6	7.8	8	2.1	35.9
October, 1924	3.5	1.8	31.4	49.5	6.7	7.1	8	1.8	36.1
November, 1924	2.8	1.8	31.3	49.6	7.2	7.3	8	1.4	35.8
December, 1924	2.9	1.7	32.1	48.9	6.7	7.7	11	1.5	35.3
January, 1925	2.9	1.7	32.1	49.6	6.2	7.5	8	1.5	35.8
February, 1925	2.9	1.6	32.6	49.3	6.3	7.3	9	1.5	35.5
March, 1925	3.1	1.5	32.6	49.5	6.1	7.2	7	1.6	35.7
April, 1925	7.4	2.2	29.2	48.3	5.6	7.3	8	3.7	37.5
May, 1925	6.5	2.0	29.3	48.7	6.1	7.4	13	3.3	37.2
June, 1925	6.6	2.0	29.2	47.9	6.5	7.8	8	3.3	36.7
July, 1925	5.3	2.0	29.5	50.3	5.9	7.0	3	2.7	37.6
August, 1925	4.8	2.3	29.2	50.2	6.6	6.9	5	2.4	37.5
September, 1925	5.4	2.1	30.0	47.6	7.0	7.9	4	2.7	36.0
October, 1925	7.1	2.1	29.0	46.5	6.9	8.4	4	3.6	36.1

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Grass, range	3.7	1.2	35.2	44.3	6.1	9.5	1	1.9	32.5
Grass, Lagumain di nosse	2.9	1.0	31.9	49.1	7.2	7.9	1	1.5	34.9
Grass, Sporobolus Berteroanus	5.7	1.1	29.7	48.3	6.2	9.0	1	2.9	35.8
Grass, stipa	6.4	1.6	30.5	40.3	5.9	15.3	1	3.2	31.5
Grass, water, etc.	6.7	1.5	29.0	46.9	7.5	8.4	1	3.4	35.7
Guajilla bush, dried	16.4	4.0	20.0	44.9	8.2	6.5	3	1.4	31.6
Guam grass, dried	8.4	1.7	26.0	49.4	7.7	6.8	2	4.3	34.8
Guar bean (seed and pod)	14.3	1.2	15.8	54.2	7.3	7.2	1	11.7	73.6
Guar (bean) fodder or hay	15.3	1.7	21.5	42.4	6.9	12.2	2	11.4	42.4
Guar leaves only (dried)	28.7	2.7	10.0	36.7	7.3	14.6	2	19.7	47.8
Guar roots	7.9	.4	45.3	33.8	5.7	6.9	2	----	----
Guar, stalks	12.7	.9	39.2	32.8	6.1	8.3	----	----	----
Hay, Brazos co., prairie	6.2	2.8	29.7	47.2	6.2	7.9	1	3.1	36.7
Hay, Brazoria county, prairie	4.2	2.0	29.5	47.7	8.4	8.2	2	2.1	35.4
Hay, Crenega (New Mexico)	7.1	1.7	26.5	45.5	7.5	11.7	1	3.6	35.1
Hay, Galveston county, prairie	4.2	1.8	30.5	48.3	7.7	7.5	3	2.1	35.6
Hay, Harris county, prairie	4.2	2.5	31.9	48.7	6.6	6.1	1	2.1	36.5
Hay, ground, sorghum	6.2	2.4	23.1	53.3	6.3	8.7	1	2.0	39.3
Hay, Jackson county (South Texas)	2.2	2.2	30.6	46.1	7.8	9.2	1	2.1	34.5
Hay, Juncus filiformis	8.1	2.5	25.0	52.2	6.0	6.2	1	4.1	40.5
Hay, Oklahoma prairie	5.1	3.1	29.3	47.9	8.2	6.4	1	2.6	36.9
Hay, prairie, black land, Johnson county	5.9	1.3	28.1	44.2	6.3	14.2	1	3.0	33.4
Hay, prairie, Parker co., Texas	4.2	3.4	30.5	48.7	7.5	5.7	1	2.1	37.2
Hay, prairie upland, Texas	5.3	1.8	30.1	47.0	7.4	8.4	12	2.7	35.3
Hay, range, Jefferson county	6.2	1.7	35.5	43.0	6.6	7.0	1	3.1	33.4
Hay, South Texas prairie	4.0	2.1	29.7	47.2	8.9	8.1	2	2.0	35.0
Hay, Texas prairie, El Paso	5.0	2.0	34.4	43.4	7.8	7.4	1	2.5	33.2
Hay, prairie, sandy land, Johnson co.	6.6	1.6	28.9	47.7	6.3	8.9	1	3.3	36.3
Hay, vega, New Mexico	6.4	2.0	29.2	45.7	7.1	9.6	1	3.2	35.2
Hay, wild pea	11.4	1.7	29.1	43.3	6.5	8.0	1	7.8	37.5
Hegari, grain or chops	11.4	2.1	2.4	70.8	11.8	1.5	8	8.8	83.7
Hegari chops (minimum)	10.0	2.5	3.0	70.0	----	----	----	6.9	77.4
Hegari fodder, with heads	7.4	2.0	17.2	55.3	10.3	7.8	16	3.9	47.2
Hegari heads	9.5	1.9	11.6	62.1	10.7	4.2	6	6.6	68.9
Hegari heads, stalks & stems (minimum)	7.0	2.0	20.0	55.0	----	----	----	2.7	55.1
Hegari head chops	9.3	2.4	6.5	70.2	7.4	4.2	3	6.4	77.3
Hegari silage	2.5	.9	6.3	18.8	67.2	4.3	1	.7	13.8
Hegari silage (dried)	7.1	2.7	18.3	54.4	5.0	12.5	1	2.0	39.9
Hegari stover, no heads	5.5	1.9	28.5	43.7	11.0	9.4	9	2.2	34.3
Hickory nuts with shells	3.6	12.3	56.3	19.1	7.4	1.3	1	----	----

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Hominy feed	11.1	7.4	6.5	62.9	9.5	2.6	223	7.6	85.5
Hominy feed (minimum)	10.0	6.0	7.0	60.0	----	----	----	6.8	78.5
Honeysuckle, wild (green)	2.9	.8	11.3	17.0	65.7	2.3	1	2.0	13.8
Honeysuckle, wild (dried)	7.9	2.1	30.8	46.4	6.5	6.3	1	5.4	37.4
Ice cream cone	13.2	1.2	1.0	74.6	8.6	1.4	1	10.7	92.5
Jack bean (Canalvia ensiformis)	24.9	3.3	8.1	50.3	10.6	2.8	3	----	----
Japanese bean meal	21.0	1.2	4.4	62.8	7.1	3.5	1	18.3	84.9
Johnson grass, green	3.0	1.2	5.6	8.1	80.2	1.9	7	1.3	7.9
Johnson grass hay	6.1	1.7	29.1	45.6	7.4	10.1	8	2.7	34.7
Johnson grass hay, U. S. coarse	7.4	1.4	35.3	41.9	6.3	7.7	1	3.3	33.3
Johnson grass roots, dried	4.7	.8	17.3	63.2	6.8	7.2	4	2.1	42.9
Johnson grass silage green	3.0	1.0	10.6	14.2	69.0	2.2	1	1.3	11.9
Johnson grass silage, dried	9.1	3.1	32.3	43.0	5.8	6.7	1	4.0	36.0
Kafir chop (minimum)	10.0	2.5	3.0	70.0	----	----	----	7.7	83.0
Kafir grain or chops	11.2	2.9	2.3	71.1	10.5	2.0	199	8.6	85.8
Kafir meal	11.6	2.7	2.4	70.2	11.4	1.7	5	8.9	84.8
Kafir flour	8.2	1.8	.5	76.3	9.9	3.3	1	6.3	86.6
Kafir fodded, with grain	10.3	2.8	18.7	46.0	13.2	9.0	17	5.4	42.9
Kafir heads	10.1	2.3	10.2	63.2	10.8	3.4	13	7.0	71.0
Kafir head chops	10.2	2.8	6.9	66.6	10.3	3.2	28	7.1	75.1
Kafir head chop (minimum)	8.5	2.5	8.0	65.0	----	----	----	5.9	71.9
Kafir head stems	5.7	1.2	22.6	54.8	8.5	7.2	5	1.2	22.3
Kafir heads, stalks & stems (minimum)	7.0	2.0	20.0	55.0	----	----	----	3.7	46.8
Kafir stalks	7.0	1.6	25.6	44.7	12.6	8.5	2	2.8	27.8
Kafir stover, no seed	5.2	2.0	30.9	45.7	6.4	9.8	2	2.1	28.2
Kaoliang, grain	10.3	2.8	3.8	71.8	9.4	1.9	6	7.6	85.0
Kudzu plant, dried	13.2	2.0	29.9	39.2	6.7	9.0	3	9.1	35.9
Lechuguilla (fiber plant)	7.0	1.8	27.1	51.9	3.6	8.6	3	----	----
Lechuguilla, moist	3.1	.8	11.6	22.1	58.7	3.7	3	----	----
Linseed meal, 34% protein, old process	35.0	6.5	8.6	36.5	.1	5.3	35	29.4	77.6
Linseed meal, 34% protein (minimum)	34.0	6.0	9.0	35.0	----	----	----	28.5	74.2
Linseed meal, 32% protein	32.2	10.2	9.9	37.6	5.3	4.8	2	27.0	85.0
Linseed meal, 32% protein (minimum)	32.0	6.0	9.0	35.0	----	----	----	26.9	72.5
Linseed meal, 37% protein	38.1	5.2	7.5	35.4	8.6	5.2	2	32.0	76.1
Locust bean meal	5.1	.6	6.3	77.8	7.0	3.2	1	3.8	79.9
Loose grass or goose grass	4.2	1.3	30.3	45.1	7.5	11.6	5	2.1	33.2
Malt sprouts	16.1	1.2	8.4	63.4	6.7	4.2	1	12.3	64.1
Maquey leaf, dried	6.3	1.1	13.6	53.5	15.1	10.4	2	2.0	37.6
Meat and bone meal, 50% protein	50.8	9.9	2.2	2.1	5.8	29.2	32	44.7	71.1
Meat and bone scraps, 50% protein	52.1	10.7	2.4	3.3	5.6	25.9	62	51.5	80.0

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Meat and bone meal, 55% protein	56.6	12.3	1.5	.5	5.2	23.9	3	49.8	80.3
Meat and bone meal with cracklings	50.2	9.6	2.0	3.5	5.3	29.4	7	44.2	71.4
Meat meal	60.0	10.0	2.8	3.5	6.1	17.6	29	52.8	81.1
Meat meal (minimum)	50.0	6.0	3.0	2.0	----	----	----	44.0	61.1
Meat scraps, 60% protein	61.2	11.8	3.2	1.7	6.2	15.9	26	60.5	92.0
Meat scraps, 65% protein	69.2	11.9	2.0	2.6	5.9	8.4	3	68.4	100.3
Melon (stock) entire melon with seeds	.4	.3	1.5	3.0	94.3	.5	----	.2	4.0
Melon (stock) meat	.2	.1	.5	2.3	96.6	.3	1	----	----
Melon (stock) rind	.3	.1	1.5	3.3	94.3	.5	1	----	----
Melon (stock) seed	5.6	7.5	13.8	4.3	68.3	.5	1	----	----
Meng bean, (fodder)	14.4	1.8	22.2	43.7	8.7	9.2	1	10.7	42.9
Meng bean seed	30.6	1.6	5.7	48.5	9.0	4.6	1	22.7	61.2
Mesquite beans with pod	12.8	2.2	27.0	48.2	5.5	4.3	7	9.6	63.9
Mesquite beans, no pod	38.0	4.6	7.0	34.2	11.6	4.6	1	31.2	76.0
Mesquite grass	6.9	1.9	26.2	43.3	7.0	14.7	26	3.5	33.7
Mexican weed seed	16.8	30.9	35.2	6.8	7.0	3.3	1	----	----
Milk, dried, skimmed	35.6	.3	.1	51.3	5.1	7.6	10	33.5	85.8
Milk, dried, skimmed (minimum)	34.0	.2	0	50.0	----	----	----	32.2	82.8
Milk sugar feed	12.2	.1	.2	78.3	3.5	5.7	1	9.9	93.7
Millet, seed	11.5	3.8	9.5	62.3	9.6	3.3	1	6.8	66.4
Millet seed (minimum)	11.0	4.0	10.0	57.0	----	----	----	6.5	61.5
Millet fodder	4.2	1.6	27.9	47.9	9.4	9.0	2	2.6	44.3
Milo chop (minimum)	10.0	2.5	3.0	70.0	----	----	----	7.3	82.4
Milo grain or chops	11.1	2.9	2.5	70.9	10.7	1.9	652	8.1	84.8
Milo flour	9.3	2.1	.4	79.8	7.3	1.2	1	6.0	83.4
Milo fodder	8.8	2.7	18.6	44.9	16.6	8.4	11	3.4	48.2
Milo forage, no heads	3.3	1.6	33.5	45.0	6.4	10.2	2	1.3	34.1
Milo heads	10.1	2.5	6.8	67.1	10.0	3.5	224	7.6	77.5
Milo head chop (minimum)	8.0	2.5	8.0	65.0	----	----	----	6.1	73.7
Milo heads, stalks and stems, ground	7.4	1.9	16.2	57.3	9.2	8.0	3	2.8	56.4
Milo heads, stalks and stems (minimum)	6.5	1.9	20.0	55.0	----	----	----	2.5	54.7
Milo head stems	6.4	1.5	21.5	56.1	8.2	6.3	9	1.3	23.7
Milo head stems (minimum)	5.0	1.0	25.0	53.0	----	----	----	1.0	20.5
Milo meal	9.9	2.9	3.7	69.9	11.0	2.6	17	7.6	85.3
Milo silage	2.3	.5	6.5	21.0	67.7	2.0	1	.4	15.1
Milo screenings	11.6	3.0	3.1	66.8	10.3	5.2	2	8.8	79.6
Milo stalks	2.9	1.3	31.9	45.1	8.4	10.4	2	0	28.1
Mistletoe	9.0	2.3	8.1	19.2	59.0	2.4	1	----	----
Molasses, beet (minimum)	3.5	0	0	59.0	----	----	----	.5	57.2
Molasses, Blackstrap (minimum)	2.4	0	0	65.0	----	----	----	.3	62.8

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitro-gen-free extract	Water	Ash	No. aver-aged	Digesti-ble protein per cent	Produc-tive energy therms in 100 pounds
Molasses, feeding	3.3	......	......	63.1	27.3	6.3	28	.5	61.6
Moss (Spanish) black	2.0	.9	12.1	23.1	58.9	3.0	4	.2	10.8
Moss (Spanish) green	4.1	1.6	24.5	53.8	8.2	7.8	6	.5	24.8
Natal grass	8.8	1.9	33.4	39.9	6.8	9.2	2	5.2	32.3
Needle grass	5.7	1.4	31.0	44.0	6.7	11.2	16	3.4	32.3
Oak leaves, live	9.2	2.6	27.9	47.1	6.4	6.8	18	0	.9
Oak leaves, shin	8.6	2.8	25.2	51.0	7.1	5.3	6	0	3.5
Oat chops, whole (minimum)	11.0	4.0	12.0	58.0	......	......	......	2.1	32.3
Oat flour	15.0	5.8	2.6	66.7	8.0	1.9	1	13.5	99.6
Oat, whole ground (chops)	12.2	4.6	11.4	58.9	9.1	3.8	413	9.6	71.9
Oat groats (minimum)	16.0	6.0	1.5	65.0	......	......	......	14.4	98.6
Oats, red, unclipped	11.6	4.5	12.5	58.3	9.5	3.6	41	9.0	69.5
Red oats, No. 1 grade	12.2	5.0	13.1	57.8	8.0	3.9	10	9.5	70.7
Red oats, No. 2 grade	11.2	5.1	13.3	58.6	8.2	3.6	11	8.7	70.8
Red oats, No. 3 grade	11.5	5.0	13.7	57.8	8.2	3.8	10	9.0	70.2
Red oats, No. 4 grade	11.4	4.8	14.3	58.1	7.8	3.6	10	8.9	70.0
Red oats, 23 lb—25 lb per bushel	12.6	4.7	13.2	57.4	7.7	4.4	3	9.8	70.0
Red oats, 25.1 lb—27 lb per bushel	10.8	4.8	13.8	58.5	8.2	3.9	8	8.4	69.8
Red oats, 27.1 lb—29 lb per bushel	11.4	4.9	12.7	58.9	8.3	3.8	23	8.9	70.7
Red oats, 29.1 lb—31 lb per bushel	11.0	5.1	12.4	59.3	8.5	3.7	33	8.6	71.1
Red oats, 31.1 lb—33 lb per bushel	11.2	5.1	12.2	59.4	8.4	3.7	16	8.7	71.3
Red oats, 33.1 lb—35 lb per bushel	12.4	4.8	11.1	59.2	8.4	4.1	4	9.8	72.7
Red oats, 35.1 lb—37 lb per bushel	15.1	5.0	8.6	59.2	8.4	3.7	1	11.8	73.6
Sample grade red oats	12.6	5.3	14.1	56.1	7.8	4.1	2	9.8	70.3
Red oats, all samples	11.4	4.9	12.8	58.6	8.6	3.7	169	8.9	70.5
Oats, so-called mill oats (wild oats)	11.3	4.8	14.0	57.2	8.7	4.0	10	9.0	68.5
Oats, white no. 1	11.1	4.6	12.2	60.1	8.1	3.9	1	8.7	70.8
Oats, white no. 2	11.5	4.5	11.6	60.4	8.5	3.5	5	9.1	72.5
Oats, white no. 3	12.5	4.1	11.9	58.8	9.1	3.6	6	9.9	71.2
Oats, white no. 4	12.7	4.4	11.6	59.9	8.1	3.3	3	10.0	72.9
Oats, white 28—29 lbs. per bushel	13.3	3.5	11.1	59.5	9.0	3.6	4	10.5	71.2
Oats, white 30—31 lbs. per bushel	12.9	3.6	11.2	59.3	9.4	3.6	2	10.2	70.9
Oats, white 31.1—33 lbs. per bushel	13.0	3.8	10.2	60.4	9.0	3.6	6	10.3	72.2
Oats, white 33.1—35 lbs. per bushel	13.2	4.1	11.1	59.0	8.8	3.8	3	10.4	71.8
Oats, white 35.1—37 lbs. per bushel	11.6	4.5	11.0	60.4	8.7	3.8	3	9.2	72.5
Oats, white, sample grade	12.6	3.9	11.0	60.7	8.9	2.9	2	10.0	72.4
Whole white oats, all	12.6	4.1	11.2	59.7	8.8	3.6	34	10.0	72.0
Oat clippings	8.8	2.3	25.3	44.9	7.8	10.9	5	3.5	37.3
Oats, clipped, by-product	6.0	2.0	30.0	35.0	......	......	......	......	......
Oat fodder, green, 4 in. high, dried	30.6	6.1	16.2	25.7	5.5	15.9	1	17.9	40.9

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Oat fodder, green, 27 inches high	12.7	4.0	25.5	43.5	5.8	8.5	2	7.4	38.5
Oat fodder, green, 30 in. high, dried	9.5	3.1	29.7	43.7	7.1	6.9	1	5.6	35.8
Oat fodder, green dried, headed	7.7	3.6	26.3	47.3	6.2	8.9	1	4.5	37.3
Oat fodder, green, 4 inches high, moist	4.2	.8	2.2	3.6	87.0	2.2	1	2.5	5.6
Oat fodder, green, 27 in. high, moist	1.8	.6	3.7	6.3	86.4	1.2	2	1.1	5.6
Oat fodder, green, 30 in. high, moist	2.9	.9	9.0	13.2	71.9	2.1	1	1.7	10.8
Oat fodder, green, headed, moist	3.9	1.8	13.1	23.6	53.2	4.4	1	2.3	18.7
Oat hay	8.3	2.7	25.7	45.0	8.4	9.7	3	4.5	34.7
Oat hulls, ground	4.6	1.4	30.2	50.7	6.5	6.6	15	.9	31.2
Oat hulls (minimum)	3.0	1.0	30.0	51.0	—	—	—	.6	22.9
Oat meal or oat flakes	14.9	5.4	3.5	65.8	8.2	2.2	10	13.4	98.1
Oat groats or oat groats, rolled	16.1	6.0	1.9	65.7	8.4	1.9	87	14.5	99.7
Oat meal, fine feeding	14.1	6.4	6.1	61.4	8.5	3.5	1	12.7	96.6
Oat meal mill by-product	6.1	2.0	28.1	50.6	6.7	6.5	19	3.7	31.9
Oat meal mill by-product (minimum)	6.0	2.0	26.0	50.0	—	—	—	3.6	31.5
Oat meal mill by-roduct high grade	14.0	4.6	17.2	52.6	5.4	6.2	3	8.4	42.2
Oat screenings	8.9	2.8	21.3	50.7	9.1	7.2	3	.8	32.2
Oat shorts, or middlings (minimum)	15.0	6.0	1.0	65.0	—	—	—	12.1	93.2
Okra seed	20.0	16.0	26.1	23.8	9.5	4.6	1	14.7	69.7
Orange pulp and peel (dried)	8.1	1.6	9.9	67.7	9.4	3.3	2	6.4	80.2
Paille finne grass	11.7	2.0	25.8	38.9	9.8	11.8	2	7.0	33.3
Paille fine hay, (minimum)	11.0	2.0	25.0	40.0	—	—	—	6.6	33.5
Palm kernel meal	18.4	1.3	16.0	52.1	7.8	4.4	1	—	—
Palmetto seed	7.1	3.2	14.4	71.0	1.4	2.9	1	—	—
Para grass	3.3	.9	33.8	46.5	8.4	7.1	2	1.7	33.4
Peas (seed)	23.0	1.6	3.8	58.2	10.2	3.2	2	—	—
Peas, Canadian (minimum)	24.0	1.2	5.0	55.0	—	—	—	20.0	76.6
Pea vine, wild (dry)	19.7	2.0	21.0	40.9	8.3	8.1	2	—	—
Pea vine, wild (green)	7.1	.7	6.9	13.4	68.7	3.2	1	5.8	17.2
Peanut hay (minimum)	10.0	3.5	24.0	44.0	—	—	—	—	—
Peanut hay, few nuts	9.8	2.9	23.1	46.5	8.1	9.6	54	7.4	45.2
Peanut hay with nuts	13.2	10.5	22.1	33.7	8.4	12.1	18	10.0	54.5
Peanut hay with nuts (minimum)	12.0	12.0	25.0	30.0	—	—	—	—	—
Peanuts, whole, including shell	25.5	36.6	17.3	12.1	5.7	2.8	57	20.6	106.6
Average ten highest in fat	25.9	39.5	16.0	10.7	5.5	2.4	10	20.9	114.1
Average ten lowest in fat	25.6	33.6	19.6	13.6	5.7	2.9	10	19.9	98.3
Average ten highest in fiber	24.1	34.2	20.5	12.7	5.8	2.7	10	19.5	99.0
Average ten lowest in fiber	26.8	38.1	15.1	11.4	5.7	2.9	10	21.7	111.7
Average ten highest in protein	27.8	37.0	15.9	11.0	5.6	2.7	10	22.5	109.7
Average ten lowest in protein	23.1	35.4	19.3	13.3	5.6	3.3	10	18.7	101.4

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Peanut hulls (minimum)	8.0	1.5	55.0	25.0	-----	-----	-----	-----	-----
Peanut hulls, clean, average (58) Texas	6.8	1.1	60.8	19.6	7.5	4.2	58	3.5	0
Average ten highest in fiber	5.6	.6	67.6	15.9	7.3	3.0	10	-----	0
Average ten lowest in fiber	7.9	2.0	55.0	21.8	7.8	5.5	10	-----	0
Peanut hulls or shells, commercial	8.0	2.5	52.6	22.1	8.7	6.1	14	4.1	0
Peanut kernels or meats	31.5	47.2	3.8	10.0	5.1	2.4	65	28.0	153.8
Peanut kernels (minimum)	26.0	44.0	3.0	17.0	-----	-----	-----	-----	-----
Peanuts, 36% protein whole-pressed	37.7	8.7	13.6	27.5	6.8	5.7	13	30.5	52.3
Peanuts, 36% protein whole-pressed (minimum)	36.0	6.0	22.0	20.0	-----	-----	-----	29.1	41.3
Peanuts, 34% protein whole-pressed	34.0	8.9	22.5	22.0	8.1	4.5	28	27.5	46.8
Peanuts, 34% protein whole-pressed (minimum)	34.0	6.0	24.0	20.0	-----	-----	-----	27.5	39.2
Peanuts, ground, whole-pressed	34.4	10.1	20.8	22.3	7.5	4.9	41	27.8	50.5
Peanuts, hog meats	17.4	6.7	5.5	60.2	7.1	3.1	1	15.5	86.6
Peanuts, hog shells	4.9	.8	41.8	42.7	5.6	4.2	1	-----	0
Peanuts, hog vine	10.4	5.6	25.4	49.1	5.5	4.0	1	7.4	49.1
Peanut cake, 43% protein	42.2	11.0	13.2	23.2	5.7	4.7	2	37.5	87.0
Peanut cake, 43% protein (minimum)	43.0	6.0	12.0	23.0	-----	-----	-----	38.2	75.2
Peanut cake, 45% protein	44.4	8.0	9.0	26.7	6.6	5.3	1	39.4	84.4
Peanut cake, 45% protein (minimum)	45.0	6.0	10.0	23.0	-----	-----	-----	40.0	76.8
Peanut culls	13.8	8.6	24.3	41.7	5.8	5.8	3	11.2	31.7
Peanut oil cake	42.3	9.3	11.5	24.5	7.1	5.3	12	37.6	83.9
Peanut meal, 45% protein (minimum)	45.0	6.0	10.0	23.0	-----	-----	-----	-----	-----
Peanut meal, 43% protein (minimum)	43.0	6.0	12.0	23.0	-----	-----	-----	-----	-----
Peanut oil meal	47.3	9.6	7.6	23.7	6.2	5.6	13	42.0	88.2
Peanut meal, 43% protein	44.5	9.1	9.2	24.9	5.5	6.8	16	39.5	85.6
Peanut meal, 45% protein	44.7	7.4	10.4	27.1	6.2	4.2	1	39.7	83.7
Peanut meal, 48% protein	51.3	8.0	5.7	22.2	7.0	5.8	1	45.6	86.3
Peanut screenings, ground	14.8	8.2	25.4	39.3	7.6	4.7	6	9.6	50.2
Peanut skins	12.0	2.2	30.9	40.0	9.7	5.2	1	3.0	5.3
Peanut stems	12.0	2.7	22.4	45.8	7.8	9.2	3	6.4	27.7
Pecans, meat	10.8	71.3	2.7	10.3	3.3	1.6	12	9.2	195.5
Pecan hulls	1.9	.6	54.6	32.6	8.1	2.2	4	0	0
Pepper seed, chili	17.0	25.0	30.4	18.4	5.9	3.3	1	12.0	46.7
Persimmon (Mexican) plant (shrub)	10.0	10.5	21.2	42.9	5.9	9.5	1	3.2	43.5
Popping weed, dry	19.0	2.0	20.5	40.8	7.8	9.9	1	13.0	42.1
Popping weed, green	2.4	.3	2.6	5.2	88.3	1.2	1	1.7	5.4
Prairie senna, dried	13.1	3.0	31.4	39.2	8.9	4.4	2	7.8	35.6
Prairie sunflower, dried	9.2	6.2	31.9	32.8	9.5	10.4	1	2.9	32.0
Prickly pears, dried	4.3	1.7	9.1	56.7	7.1	21.1	2	2.8	51.5
Pyra hay	12.0	2.1	30.2	33.7	9.0	13.0	1	8.5	34.9

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitro-gen-free extract	Water	Ash	No. aver-aged	Digesti-ble protein per cent	Produc-tive energy therms in 100 pounds
Rhodes grass hay	5.6	1.3	33.0	43.1	8.1	8.9	19	2.5	36.1
Rice, ground whole	7.6	1.9	9.2	64.8	11.5	5.0	11	5.8	70.2
Rice, brown	9.1	2.0	1.1	74.5	12.2	1.1	16	6.5	85.1
Rice from second break huller	9.0	.6	.5	76.4	12.8	.5	15	----	----
Rice, head or fancy rice	8.8	.4	.4	77.3	12.5	.6	12	6.2	84.0
Rice, cleaned (minimum)	9.0	1.0	1.0	77.0	----	----	----	6.4	85.1
Rice, rough	8.0	1.4	8.5	65.6	11.7	4.8	14	6.1	70.5
Rice, rough (minimum)	7.0	1.8	10.0	63.0	----	----	----	5.3	67.6
Rice from huller	8.8	.9	.6	76.3	12.7	.7	11	----	----
Rice bran	12.8	13.1	12.7	41.7	9.0	10.7	516	8.9	69.9
Rice bran (minimum)	11.0	10.0	15.0	42.0	----	----	----	7.6	62.0
Rice bran from pearling cones	15.4	16.0	5.7	46.0	9.8	7.1	8	10.6	81.2
Rice huller bran, Honduras	14.9	15.1	6.7	45.5	10.4	7.4	9	10.3	78.5
Rice huller bran, Blue Rose	15.3	18.8	8.5	40.3	9.7	7.4	10	9.8	79.3
Rice huller bran, Japan	14.3	16.4	9.1	43.6	9.1	7.5	4	----	----
Rice dust	6.2	3.6	23.5	31.0	8.1	27.6	9	----	----
Rice flour	7.8	.3	.7	81.2	9.3	.7	1	5.5	86.9
Rice hay	5.7	1.4	31.0	39.8	7.0	15.1	2	2.2	22.0
Rice hulls	3.1	.9	40.1	28.9	8.1	18.9	26	.1	0
Rice hulls (minimum)	3.0	.5	36.0	30.0	----	----	----	.1	0
Rice polish	12.7	11.4	3.5	56.5	9.7	6.2	218	9.0	90.7
Rice polish (minimum)	11.0	6.0	4.0	55.0	----	----	----	7.8	75.9
Rice polish from brushes	12.9	9.1	2.1	61.8	9.9	4.2	10	9.2	91.0
Rice screenings, cleaned	8.9	1.0	.9	77.1	11.4	.7	17	6.3	85.2
Rice screenings, (minimum)	9.0	3.0	6.0	50.0	----	----	----	6.8	59.4
Rough rice screenings (chicken feed)	9.6	3.0	6.0	54.3	10.3	16.8	7	----	----
Rice stone bran	9.8	7.7	20.9	36.7	9.7	15.2	22	6.8	49.2
Rice straw	3.7	1.5	31.6	40.1	7.1	16.0	7	.8	21.8
Rye chop	14.5	1.9	2.9	67.5	10.9	2.3	2	12.2	81.6
Rye chop (minimum)	10.0	1.5	2.0	72.0	----	----	----	8.4	81.6
Rye, ground	13.3	1.9	2.5	69.6	10.5	2.2	2	11.2	73.6
Rye bran	20.0	3.6	6.5	56.0	9.7	4.2	2	16.1	76.4
Rye flour	10.8	2.9	1.3	73.2	10.7	1.1	1	9.1	85.5
Rye middlings	17.0	3.6	6.2	60.1	8.8	4.3	12	14.4	79.0
Rye gray shorts	16.9	3.4	6.5	59.7	9.5	4.0	7	14.3	78.2
Sacahuista buds	23.7	2.5	15.0	44.4	8.9	5.5	1	12.3	38.4
Sacahuista fruit, seed and chaff	14.0	13.5	9.7	54.6	5.2	3.0	1	10.6	85.2
Sacahuista grass, dried	5.9	2.8	39.3	42.1	6.2	3.7	15	.7	21.0
Salt marsh grass	11.7	2.0	33.3	39.1	8.3	5.6	1	6.9	38.0
Screenings	11.3	3.9	11.0	58.8	9.4	5.6	8	1.0	40.4

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Screenings from sudan grass seed	13.1	3.5	4.4	66.3	9.9	2.8	2	10.2	74.5
Sesame oil cake	40.4	16.0	6.1	19.9	7.1	10.5	3	36.7	68.9
Sesame oil-meal	40.3	9.4	6.4	24.0	6.8	13.1	1	33.5	75.3
Shallu (grain) Egyptian wheat	12.5	3.7	2.3	70.0	9.9	1.6	5	9.6	87.2
Shallu heads	9.8	3.2	6.6	65.7	11.8	2.9	1	6.2	68.5
Shallu forage	2.8	1.4	35.5	45.4	7.0	7.9	2	.8	20.4
Shrimp, dried cooked	45.0	3.4	8.5	6.6	7.8	28.7	1	37.4	51.8
Shrimp scraps	50.0	2.4	13.6	6.9	4.6	22.5	1	41.8	53.0
Silage (sorghum and cowpeas)	2.2	.7	8.5	18.3	68.4	1.9	1	.5	13.0
Soap weed, root	4.1	1.4	30.0	53.4	6.2	4.9	2	.2	32.4
Sorghum, seed	9.5	2.9	7.8	67.5	9.1	3.2	12	5.4	76.3
Sorghum bagasse	3.0	1.4	29.5	56.4	5.8	3.9	2	.2	23.4
Sorghum chop (minimum)	9.0	2.5	3.0	69.0	-----	-----	-----	-----	-----
Sorghum and feterita silage	2.3	1.0	8.3	23.5	62.5	2.4	3	.4	18.1
Sorghum fodder, sumac	5.4	2.0	17.9	43.9	23.3	7.5	12	1.7	32.4
Sorghum fodder, red top	4.8	2.0	19.1	43.7	24.5	5.9	9	1.5	32.2
Sorghum hay or fodder	5.7	2.2	19.0	48.5	18.6	6.0	27	1.8	35.7
Sorghum hay, ground (minimum)	5.3	2.8	28.5	48.0	-----	-----	-----	1.7	36.3
Sorghum head chop (minimum)	8.0	2.5	8.0	65.0	-----	-----	-----	4.5	72.7
Sorghum leaves, sumac	10.1	6.5	13.0	57.8	6.6	6.0	3	6.1	54.2
Sorghum silage	2.1	.8	7.9	17.5	69.1	2.6	29	.3	13.6
Sorghum and corn silage	4.9	1.6	13.0	36.8	39.6	4.1	1	.8	28.6
Sorghum and feterita silage (dried basis)	5.5	2.5	20.4	58.4	7.1	6.1	2	.9	45.0
Sotal bulb, green	3.1	.8	11.3	26.2	56.3	2.3	3	2.3	25.0
Sotal bulb, dried	6.2	1.7	26.1	57.2	4.2	4.6	4	2.0	41.0
Sotal leaves, dried, Dasylirion	4.8	2.0	40.0	40.3	8.2	4.7	4	.6	19.7
Sotal leaves, green	3.2	1.5	22.4	24.1	46.5	2.3	2	.4	12.0
Soy beans, seed	39.6	17.8	7.2	22.5	8.2	4.7	2	35.8	96.3
Soy bean hay	17.7	5.8	31.1	29.0	10.2	6.2	1	12.7	39.2
Soy bean oil meal	44.6	7.2	5.1	29.2	7.9	6.0	2	37.2	81.8
Soy bean oil meal (minimum)	41.0	6.0	6.0	28.0	-----	-----	-----	34.2	75.1
Star grass, legume	16.0	1.1	22.8	37.1	11.9	11.1	1	11.0	36.4
Sudan grass, green, tall	2.2	.4	6.0	5.3	84.3	1.8	3	1.6	7.3
Sudan grass, tall, dried	12.0	2.3	30.3	38.3	7.6	9.5	2	6.9	31.6
Sudan grass, young, green	3.4	.7	3.4	5.6	85.1	1.8	2	2.5	8.4
Sudan grass cut green, dried, young	21.7	4.4	21.9	35.3	5.5	11.2	2	15.7	53.0
Sudan grass hay	8.6	1.8	29.7	43.4	8.4	8.1	23	4.5	33.9
Sudan grass seed, no glume	16.1	3.3	1.8	68.4	8.9	1.5	2	11.8	86.8
Sudan grass seed, with glume	13.8	3.1	6.8	62.3	9.4	4.6	4	10.1	79.1
Sunflower seed (minimum)	16.0	21.0	30.0	21.0	-----	-----	-----	81.9	13.3

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash	No. averaged	Digestible protein per cent	Productive energy therms in 100 pounds
Sweet potatoes, dried	7.4	.9	2.9	80.7	4.4	3.7	11	5.7	88.8
Sweet potatoes, original basis	2.1	.3	1.0	28.1	67.3	1.2	8	1.7	32.2
Sweet potato peelings	5.1	1.3	4.0	35.8	46.2	7.6	2	-----	-----
Sweet potato silage	2.4	.4	1.8	20.6	73.5	1.3	1	1.7	16.8
Tobosa grass hay	3.6	1.2	32.8	45.8	6.6	10.0	2	1.8	33.3
Tallow weed, dried	11.5	1.4	12.6	40.7	7.4	26.4	7	7.9	37.3
Tankage, digester (minimum)	60.0	5.0	3.0	0	-----	-----	-----	41.7	54.1
Tankage, digester, 60%	60.9	8.3	2.1	2.4	7.5	18.8	61	42.3	64.4
Tankage, digester, 45—50%	48.6	9.7	2.8	2.9	6.7	29.3	11	33.8	59.7
Tumble weed	11.9	3.2	32.2	34.8	8.0	9.9	1	7.0	36.3
Velvet beans, without pods	23.6	6.0	7.0	50.5	9.8	3.1	9	20.6	81.8
Velvet bean meal (minimum)	22.0	4.5	4.0	51.0	-----	-----	-----	16.5	74.1
Velvet bean pods	4.6	.8	28.0	48.2	11.4	7.0	4	2.3	34.9
Velvet beans and pods	17.6	4.7	13.4	50.2	9.7	4.4	35	13.2	71.9
Velvet beans with pods (minimum)	17.0	3.5	17.0	48.0	-----	-----	-----	12.7	67.7
Vetch hay	15.0	1.6	27.3	37.4	6.8	11.9	2	10.3	35.8
Vetch, wild	14.5	1.5	35.7	30.9	8.0	9.4	1	10.0	29.7
Water grass (goose grass and others)	6.7	1.5	29.0	46.9	7.5	8.4	1	3.4	35.7
Water lilies, green	1.9	.3	1.6	5.6	89.4	1.2	2	.7	5.3
Wheat	14.0	1.7	3.0	69.4	10.0	1.9	14	11.3	78.8
Wheat chops	15.1	2.0	3.2	67.7	9.8	2.2	104	12.2	82.9
Wheat chops (minimum)	12.0	2.0	3.0	70.0	-----	-----	-----	9.8	84.0
Wheat bran	16.9	4.0	8.8	54.9	9.7	5.7	458	13.3	56.8
Wheat bran (minimum)	14.5	3.0	10.0	50.0	-----	-----	-----	11.4	50.9
Wheat bran and screenings or scourings	16.8	4.1	9.4	53.9	9.7	6.1	849	12.9	49.3
Wheat bran and scourings	16.1	4.4	9.5	54.7	8.3	7.0	2	12.3	56.9
Wheat brown shorts	18.0	4.7	6.2	56.7	10.0	4.4	195	14.8	64.7
Wheat brown shorts (minimum)	17.5	4.5	7.5	53.0	-----	-----	-----	14.4	61.5
Wheat brown shorts and screenings	17.6	4.5	6.6	56.9	9.8	4.6	72	14.5	64.3
Wheat chaff	12.1	2.6	18.5	47.9	8.8	10.1	1	2.3	29.1
Wheat flour, low grade	14.2	2.1	1.3	70.3	10.8	1.3	21	11.2	85.0
Wheat flour, red dog	16.1	2.8	2.6	66.2	10.1	2.2	49	12.7	83.5
Wheat germs	27.3	8.4	3.1	47.7	8.9	4.6	5	22.4	85.5
Wheat germs (minimum)	30.0	10.0	2.5	45.0	-----	-----	-----	24.6	87.9
Wheat gray shorts	18.0	4.5	5.6	57.8	10.0	4.1	1083	14.9	75.7
Wheat gray shorts (minimum)	17.0	4.0	6.0	55.0	-----	-----	-----	14.0	71.3
Wheat gray shorts and screenings	17.7	4.4	6.1	57.2	10.2	4.4	573	14.6	74.7
Wheat gray shorts and scourings	17.4	4.2	5.9	57.4	10.3	4.8	10	14.4	74.2
Wheat hay, dough stage	9.8	1.4	25.1	44.7	12.1	6.9	3	5.4	34.2
Wheat mixed feed	17.3	4.1	7.6	56.1	10.0	4.9	194	13.3	48.4

Table 11. Average percentage composition of feeds, and approximate digestible protein and productive energy for ruminants.—(Continued.)

	Protein	Ether extract	Crude fiber	Nitro-gen-free extract	Water	Ash	No. aver-aged	Digesti-ble protein per cent	Produc-tive energy therms in 100 pounds
Wheat mixed feed (minimum)	16.0	3.5	8.5	52.0	.....	.....	....	12.3	45.1
Wheat mixed feed and screenings	16.8	4.1	8.4	55.6	9.6	5.5	195	12.9	48.1
Wheat middlings and screenings	15.9	4.0	7.5	57.3	10.2	5.1	4	13.1	62.8
Wheat screenings (chiefly grain)	15.5	2.4	5.1	61.8	10.4	4.8	2	10.8	59.7
Wheat screenings (minimum)	12.5	2.5	6.0	65.0	.....	.....	....	8.7	60.5
Wheat screenings, ground	14.5	2.4	5.0	64.5	9.7	3.9	20	10.1	61.1
Wheat straw	4.5	2.7	36.5	41.0	7.4	7.9	1	.7	27.0
Wheat white shorts	16.2	3.1	2.9	65.0	10.2	2.6	207	12.8	82.8
Wheat shorts, white (minimum)	14.5	3.0	3.5	60.0	.....	.....	....	11.5	76.3
Wheat white shorts and screenings	16.2	3.2	2.4	64.8	11.1	2.3	4	12.8	82.8
Yeast, dried	41.3	.4	5.2	37.0	7.4	8.7	1	34.1	65.9
Yucca flowers	17.2	4.4	11.3	48.8	10.6	7.7	1	.....	.....

Grasses. The number of analyses and digestion experiments made with most of the grasses is not sufficient to overcome the variations in the samples due to soil, season, stage of growth and other conditions. The analyses cannot, therefore, be taken to represent accurately the composition and feeding values of the different varieties of grasses.

The analyses of grasses of Harris county show the composition at different periods of the year. It is noted that the protein content is very low during the winter months, probably insufficient for the animals.

Hays. The number of samples of the different kinds of hay is not sufficient to compensate for differences due to stage of growth, soil, and season, and the analyses cannot be taken to represent accurately the differences in the various kinds of hays listed. The same applies to the digestible protein and productive energy.

Oats. The average composition of red and white oats is given for U. S. Grades and for different bushel weights. With the red oats, there is a slight increase of crude fiber as the grade becomes poorer, and a decrease as the bushel weight becomes heavier. With the white oats, there is little relation betwen the grade and composition or the bushel weight and composition.

SUMMARY AND CONCLUSIONS

Animals require food that contains sufficient protein, that produces sufficient energy, that contains sufficient minerals such as lime, magnesia, phosphoric acid and iron, and sufficient vitamines.

Definitions are given of protein, fat, crude fiber, nitrogen-free extract, ash, nutritive ratio, and other terms used in connection with feeds.

The digestion and utilization of feeds is discussed briefly.

The productive energy of feed is defined and discussed.

The calculated productive energy for ruminants, of a large number of feeds, is given.

The variations in the composition of a number of feeds are discussed and shown by the standard deviation. Some feeds are quite variable.

The protein of cottonseed meal has decreased in variability from 1924 to 1931, and is less variable than many other feeds.

Wide variations are found to occur in the feeding value, as measured by the calculated productive energy, of alfalfa hay, corn silage, and sorghum fodder. Bermuda hay, cottonseed meal, corn chops, and wheat bran are less variable than the feeds mentioned above.

Methods of calculating the cost of digestible protein, productive energy, and bulk, are given.

Requirements for maintenance, fattening, working animals, growing animals, and milk cows are briefly discussed, with feeding standards.

Methods for calculating a ration and reducing the cost of a ration are outlined.

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